SUPPLEMENT

TO

REPORTS

ON

FOREST MANAGEMENT

IN

FRANCE, SWITZERLAND, AND LOWER AUSTRIA.

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PREFACE.

THE following papers are printed in continuation of the Reports on Forest Management in Germany, Austria, and Great Britain, which were published last year by order of Her Majesty's Secretary of State for India in Council. Colonel Pearson's Report on several forest districts, and the operations of reboisement in France supplies a want which was felt at that time, and will furnish an excellent guide for forest officers on leave from India, who may be permitted to complete their professional studies in that country. In order to obviate any misconception concerning the arrangement of their studies, I deem it right to state, that in my opinion the course prescribed in the Règlement of January 1867, which will be found at page 174 of the above publication, is the one that should be followed, that is, our forest officers should in the first instance spend several months studying in detail the management of such forest districts as may be selected for them at the Direction Générale des Forêts at Paris, and should not go to Nancy until they have acquired a good knowledge of the management and working of several forest districts. They should, as suggested by Colonel Pearson, time their arrival at Nancy so as to join the students of the Forest School at their outdoor work, and at the forest tours made during the summer months. The preparatory study in several forest districts, to which the early spring might be devoted, is in my opinion essential, in order to guard against the acquisition of incomplete and superficial knowledge which may appear valuable, but which will be of little use to them on their return to India.

Captain Campbell Walker's report on the wire tramway in Switzerland, and the brief abstract of

the report concerning the Waidhofen forests in Austria, which I have added, will I trust be found useful by those who desire particularly to study the transport of timber and the working of forests in mountainous districts. Forstmeister Fankhauser, the chief forest officer of the Canton Bern in Switzerland, and author of the pamphlet referred to by Captain Campbell Walker, has with great liberality permitted the use of the plates which are reproduced in this volume, and has at the same time offered his assistance to any forest officers from India who may be desirous of studying the system of wire tramways for the transport of timber in the forests under his charge. A wire tramway, similar to that in the Canton Unterwalden, has lately been established near Interlaken (Canton Bern), and will, he writes, remain standing during next year (1874).

It is a source of much gratification that foresters and forest officers of public and private forests in Britain, France, Germany, Austria, Italy, and Switzerland, have on all occasions manifested their readiness to assist Indian forest officers in their endeavours to place the administration and working of the forests in British India upon a satisfactory footing.

D. BRANDIS.

November 1873.

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Report on Forest Management in France, by Lieut.-Col. G. Pearson, Conservator of Forests, N.W. Provinces.

INTRODUCTION.

My object in writing the following papers lies in the hope that they may be of some use to my brother foresters from India who may wish to become personally acquainted with the system of forestry as practised in France; for to all those who command a sufficient colloquial knowledge of French for such a visit to be useful, I would say "Go and "see for yourselves."

But some will ask "What would be the use of such a "visit? What shall we see that we do not know already?"

For myself I can reply that my visit has taught me that however details of work may necessarily vary under different conditions of soil and climate, the great principles applying to vegetation (which have in France, though not yet in India, been formulated and taught scientifically as a system) are the same in India as in Europe, and that for the most part even under considerable modifications of climate and soil, the same causes are in a forest followed by the same effects.

My first advice then to all is that after first passing a sufficient time in following the course prescribed in the Règlement of January 1867, officers visiting the French

forests should go to Nancy in the spring as soon after Easter as possible, and obtain permission from the Director of the Forest School there to accompany the professors and pupils on their visits to the various forests which usually occupy the school from the middle of April to the middle of July. Moreover, if permission be obtained to mess and share expenses with the rest, the expense of such a tour will be comparatively very small. In this way the visitor will have the opportunity of hearing lectures delivered in the forest on every possible practical subject as they present themselves in succession, and of seeing the effects of the different systems of work pointed out on the spot by the ablest forest officers in France, the local forest officers being on the ground to furnish all details, and give every necessary information. The students are taken to see forests in the hills, and forests in the plains, forests well managed, and forests injured by mistakes in the operations; all will be faithfully shewn, and the reasons pointed out, why success has followed in the one case, and why with equal certainty failure in the other. Above all no one can fail to be impressed with the truth of the principles taught here regarding the system of natural reproduction, nor, as I think, to be convinced that that system is the one which must regulate all great forest operations in India; indeed that without underrating the necessity of plantations as applied to special localities and for special purposes, it is the only system which can ever be applied to the general conservancy of forests on so vast a scale as ours. Visits thus made to the continental forests cannot fail to be of use; on the other hand, it cannot be too strongly impressed on all, that desultory visits of a casual nature made alone, and without the help and explanation of those acquainted with the works, and with the past and present state of the forests, as well as with the operations carried on in them, must be useless and productive of no practical good whatever. The same may be said of rapid visits made to a number of forests in a short time "en touriste," without any definite purpose of studying them.

Finally, I can testify to the cordial welcome which English foresters will meet with from their fellow workmen in France, than whom it would be impossible to find a body of public officers more united by a feeling of *esprit de corps* and professional sympathy—a feeling which they are

ever ready, as I have so often personally experienced, to extend to their brother foresters from other countries.

And for their kindly welcome of me, I beg here to return them my most cordial thanks.

G. F. P.

Note.—In drawing up the following notes I am much indebted to Professors Bagneris and Roussel for the information they have placed at my disposal; also to the excellent Essays of Messrs. Masson and Levraut, of the Nancy Forest School; and to Surel's works on the reboisements of the Alps.

CHAPTER I.

THE FORESTS OF FRANCE.—GENERAL REMARKS ON THEIR EXTENT AND MANAGEMENT.

1. At the time of the conquest of Gaul by Julius Cæsar the extent of forest land in France has been variously estimated at from 40 to 46 millions of hectares (each hectare being equal to 2½ acres) out of a total superficial area of rather more than 53 million hectares. Gaul was even then a well peopled country. Its savage hordes, not finding sufficient space in their own territory, invaded Italy, and even penetrated in their incursions as far as Greece and Asia Minor. But after the Roman conquest the country became more settled, and large portions of the forest were cleared away, to be renewed again in the 4th and 5th centuries, when the wild Germans who over-ran the empire, being worshippers of the Sylvan deities, took the forests under their special protection. Then we are told that it cost more to cut down a tree than to kill a man. Since that time, however, the work of clearing has gone on steadily till the commencement of the present century, since which date there has been no great change in the amount of land under forest. There are statistics to show that in 1791 the total area of forest land in France, exclusive of Savoy and Nice, was 9,589,869 hectares, while in 1865 the figures stood at 8,860,000 without those provinces; or at 9,900,000 hectares, if they be included.* This area is divided approximately as follows:

	Hectares.
State forests - - - -	900,000
Belonging to Communes and other public bodies - - - - -	2,000,000
Belonging to private proprietors - -	6,000,000
In hedge rows, isolated patches and parks -	1,000,000
Total hectares -	9,900,000

* *Note.*—In both cases Alsace and Lorraine are not reckoned.

When deduction is made for all bare and unplanted spaces, rocks, and unproductive land, the figures will stand as follows:

	Hectares.
High timber forest, composed of deciduous trees, half of the area being capable of producing oak—	
State forests - - - -	180,000
Communal forests - - - -	160,000
High timber forest of coniferous trees, half of which are either silver fir or spruce—	
State forests - - - -	240,000
Communal forests - - - -	400,000
In mixed coppice, one fourth of the area belonging to the State being now under conversion to high timber forest—	
State forests - - - -	500,000
Communal forests - - - -	850,000
In simple coppice—	
Communal - - - -	250,000
Total hectares -	2,580,000

3. The first traces of forest conservancy in France may be found under the Romans; under them the forests were held to be public property, the use of which however was strictly regulated; and there were a set of forest officers called "Saltuarii," who were entrusted with their charge. After the Romans withdrew, and as the feudal system grew up in Europe, it at once affected the question of forest rights, and the lords of the manor, especially in the north of France, as they became stronger and stronger, monopolised the forest rights which formerly had belonged to the people, and so many of the forests gadually lapsed into private hands. Where this was the case the woodlands were generally well preserved by the seigneurs for the purposes of the chase. In the southern portions of the country, where the feudal system flourished with less vigour, the forests very generally remained in the hands of the Communes and other public bodies; and here the work of clearing them away proceeded far more rapidly than in the north of France.

4. As time went on, we find that laws for the protection and conservancy of the forests were passed by Philip Augustus in A.D. 1219, and also by Charles V. in A.D. 1376, while the duties and titles of forest officers were fixed

by an ordonnance of Philip le Bel in 1291. The law of Charles V. especially states that it was passed with a view to the preservation of timber for ship building. In the XVIth century, between 1515 and 1588, Francis I. and his successors published many laws for the protection of forests. But it was not till the XVIIth century, when in 1669 Colbert's celebrated edict was passed, that the subject was systematically taken in hand. On this edict, which is in itself a true forest code, is based the whole forest law of France. Since the time of Colbert, forest conservancy has constantly occupied the attention of the existing governing powers in France for the time being, the recent laws of 1860 and 1864, on the reboisement and regazonnement of the Alps, being among the most valuable additions made to forest legislation. At times, however, it must be confessed that large alienations of the State forests have been made to meet deficiencies in the public purse. Among the most notable of these was the sale of 164,000 hectares of forest in 1814 and 1817, and of 117,000 hectares in 1831. But generally the forests have been well cared for by existing governments, and their value duly appreciated.

5. The principal coniferous forests in France are found in the Vosges, in the Jura, and in the Alps. The trees which predominate in them are the *silver fir* (or sapin), the *spruce* (or epicea), and the common *Scotch fir* (or pin sylvestre). In the Vosges the greater portion of the forests consist of the sapin, which grows at an altitude of between 1,300 ft. and 4,000 ft. above the level of the sea, and is generally mixed with the beech. About 100,000 hectares in the Vosges are under forest management. In the Jura also the sapin is the predominating tree, growing from 2,000 ft. to 4,600 ft. above the sea level, while the epicea covers all the higher portions of the third plateau. The forests in the Jura, under management, cover about 60,000 hectares. In the Alps, in Auvergne, and in the Pyrenees, the same trees are found at an elevation of from 2,500 ft. to 5,300 ft. In fact it will be found that for every degree of latitude, proceeding southwards, 100 metres or 350 feet of increased elevation must be allowed to find the same vegetation, and this scale will be found true as far as the Himalayas. Between the Jura, in 46° north latitude, and the Himalaya in 32°, there is a difference of 14 degrees of latitude, which at the above scale will give a difference of 4,900 feet. If to this be added the lowest elevation at which the sapin grows in the Jura, or 2,000 ft., we shall have as a result 7,000 ft., which is the exact eleva-

tion at which the sapin (*Abies Webbiana*) commences to grow in the Himalaya.

6. The sapin (or silver fir) occupies the first place in the mountain forests of France, as the oak does in those of the plains; indeed it covers more than a third of the whole area of mountain forests. Its great value may be estimated from the fact that 20,000 hectares of silver fir forest in the forest district of Pontarlier have been valued at 120 million francs (4,800,000*l.*), and that the revenue derived from the same amounts to two millions of francs, or 80,000*l.* annually. Like the epicea (or spruce) it is found all over central Europe. The latter tree, however, loves rather the moist situations, and higher and colder climates, than the sapin. It is found in the Jura over 2,400 feet, and in Savoy over 3,000 feet above the sea level. In the Vosges it is rare, being found in situations which exceed 2,000 feet in elevation. In the Alps of Dauphine, and in the Pyrenees, it is also to be occasionally met with, though there are no forests of very great extent composed of it. The pin sylvestre on the other hand is found all over Europe, in the mountains as well as in the plains. The timber which it yields, however, is only of good quality when grown in cold situations. It covers a large extent of ground in the Alps and Pyrenees as well as in the plains to the north of 48° north latitude. In the south of France it is not found in the plains or lower hills except where artificially introduced.

7. The preponderating tree in all the plain forests of France, both in regard to its value and to the extent of ground it covers, is the oak. There are two species of the common oak in France, the chêne rouvre, and the chêne pédonculé. They are very similar in appearance and habits; however, the chêne rouvre prefers a rather drier soil and warmer climate than the chêne pédonculé, which affects moist and clayey localities. The chêne pédonculé is found almost always in the plains; the chêne rouvre, while characteristically a tree of the plains, is found very generally in undulating and hilly regions, and in the lower mountain chains.

8. It has been estimated (vide the report of the Director-General of Forests for 1868) that there are in France 150,000 hectares of oak forest capable of producing large timber, fit for naval construction and other great works, all of which belong to the State forest domain. Half of these forests lie in the basin of the Seine and half in that of the Saone. There are also 850,000 hectares of forest belonging to the Communes, a large portion of which is oak, or oak mixed with beech, but generally all capable of producing oak

timber of large dimensions, though now almost invariably under mixed coppice. All these forests merit great attention from the Indian forest officer. There is much in common between the oak and the teak, inasmuch as each occupies in its own country the first and most important place among the timber producing trees; and the conservation and reproduction of the teak is to India a question of the same vital moment as that of oak is to France.

9. In treating of the French forests, four distinct zones or regions may be recognised, each characterised by its own peculiar vegetation. These are,—

1st. The tracts lying along the shores of the Mediterranean.

2nd. The middle zone or region of the vine.

3rd. The sub-Alpine zone.

4th. The mountain or Alpine region.

The first of these regions is characterised by the olive, the evergreen oak, the pine of Aleppo, the edible pine, and the pine maritime. Above this we find the zone of the vine, a hilly tract, varying in elevation according to its latitude, and distinguished by the growth (besides the vine) of the chestnut, and the two species of common oak, known as the chêne rouvre and chêne pédonculé. The chêne rouvre, however, is found at higher elevations than the vine. In the upper portions of this zone the pin sylvestre (or Scotch fir), the sapin (or silver fir), and the beech are characteristic trees. Above this zone we find ourselves in the region of the cone bearing trees, intermingled with pasturages, known as the sub-Alpine region. The characteristic trees of this region are the spruce fir (épicéa), the silver fir (sapin), the mountain pine, and occasionally the beech. Such is the third or highest plateau of the Jura. The only cultivation which succeeds tolerably well in this region is that of the rye and the potato. Lastly, we find the Alpine region commencing at an elevation of from 5,000 to 6,000 feet above the sea, and characterised by the anemone of the Alps, the rhododendron, the larch or mélèze, the pin cembro, and the mountain pine, with occasionally the spruce. Above and mixed with these we find pasturage and shrubs of diminutive height. All vegetation ceases at from 8,000 to 8,500 feet, above which we reach the region of perpetual snow.

10. In the succeeding chapters I propose to give some account of the various forests I visited in France, which will contain examples of all these tracts except the last.

CHAPTER II.

On the Torrents and Reboisements of the French Alps.

1. Torrents are common to all mountainous countries. They are found in the Himalaya as well as in the French Alps, parts of which the former resemble in a striking manner. In the Alps the districts which have suffered most from their ravages are the valley of the Upper Durance and its affluents, and a portion of the mountains drained by the Drac. These districts comprise the greater portion of the departments of the Hautes Alpes and Basses Alpes, with portions of Jsère and the Drôme, forming a triangular block of mountainous country, of which Nice, Grenoble, and Avignon are the three corners. It was within these limits that the Moors, after being chased from the rest of the south of France, found a refuge, and after a time became merged in the surrounding population. The existing names of Pay-maure, Roche-maure, Mont-maure, Pont-maure, still attest the days of Moorish occupancy; there too, in later years, the persecuted Vaudois and Huguenots found an asylum from their enemies of the Inquisition during a period of nearly six centuries.

2. These districts, but little known to tourists in general, contain several mountains of considerable elevation. Monte Viso is 12,700 feet in length, and Le Pelvoux 13,180, and it is in the mountain chains of which these summits form the culminating points that are found the sources of the torrents which have so devastated the country as far even as Avignon.

3. The Basses Alpes may be approached easily by way of Avignon and Digne, or of Marseilles, Aix, and Pertuis; and it may be well here to mention for the guidance of any forest officers visiting the reboisements (as information even at Lyons is most difficult to obtain), that there is a regular omnibus service from the station of Peyruis (on the Avignon, Pertuis, and Sisteron line of railway) to Barcellonette passing through Digne and Seyne, also from Seyne to Gap, and from Gap to Embrun and Briancon, passing by Guillestre; also from Gap to Grenoble passing by St. Bonnet and Corps. If the Hautes Alpes are visited first, they may be approached by the Mt. Cenis line of railway, from which there is a branch from Chambéry to Grenoble. Accommodation of a sufficient nature may be found in the

auberges almost everywhere; regular hotels there are none, except at places like Digne and Gap.

4. It will now be proper to describe these torrents, and the nature of the mischief of which they are the cause.

"The torrents of the Alps" are watercourses, characterised by special peculiarities, which are further exaggerated by the peculiar geological formation of the mountains and by the climate. Their sources are hidden in the highest parts of the ranges; their outfall is poured into the streams which drain the several valleys. The upper section of the torrent called the "Bassin de réception," always more or less resembles a vast funnel, terminating at its base in a spout. Sometimes a set of cuts or trenches are formed in the mountain sides; at others, a vast morass, the drainage of which, however, tends always ultimately to form a funnel, ending in a narrow neck. The effect of this formation is to convey all the water, which falls over an extended surface, rapidly to one point, where it exercises a most destructive power. The lower section called the "Cone de déjection" consists of the vast mass of débris swept down from the mountains above. The two sections are connected by the "Canal d' écoulement," or mouth of the funnel, which is always a channel cut deep and well defined in the mountain side, its length depending mainly on the steepness of the ground.

5. But the characteristic feature which specially distinguishes these torrents from all other mountain streams is that the lower portion of their bed (or cone de déjection) is *convex* instead of being *concave*, the centre of the bed being raised higher than its flanks. The effect of this formation is to cause all the drainage from the cone to flow outwards, towards the sides; so that the bed of the torrent is continually spreading itself, and cutting away or covering over vast areas of cultivated ground. Many of these torrent beds, thus formed, are upwards of 3 kilometres in width, and between Gap and Embrun in the valley of the Durance, as also near Barcelonnette in the Ubhaye, the road passes for many miles in succession across such beds of torrents, and the débris swept down by them. In the valley of the Beouse, north of Gap, the country has obtained the name of "the Dévoluy" ("the rolled down," from devolutum), the whole mass of the soil from the overhanging mountains (of which Mont Obiou, 9,290 feet, is the principal summit), having literally been swept or rolled down into the valleys below. Thus one evil is continually feeding and as it were augmenting the other. As the pasture grounds are swept

from the mountain sides, they cover over and destroy the richly cultivated valleys below them.

6. Though the geological structure of the Alps (formed as they for the most part are of sedimentary deposits of a comparatively recent period lying in alternate beds of rocky schist and loose earth) materially facilitates the formation of torrents in these mountains, yet the immediate and active agent of mischief is the abuse of forests and pastures. Private proprietors and public bodies alike seem unable to resist the temptation of extracting the utmost present advantage from these valuable properties, without any regard to the interests of the future, and without reference to the powers of reproduction in the soil. Nevertheless, it will be found that private proprietors have continually had a truer perception of the only safe course to pursue in husbanding their forests and grazing grounds than public bodies. As regards the latter, the only motto which seems to have guided their counsels was "every one for himself." Laws to restrain unlicensed forest depredations have from time to time been passed by the government, and generally the authorities for the time being at the head of affairs have, as has been before shown, manifested a due regard for forest interests. But at certain periods, when the central authority has been weakened in France (as in 1789, 1830, and 1848), it will be found that forest interests have always been neglected and at times seriously compromised. And in the Alps the severest blow of this nature was struck in 1791 by the proclamation of Louis XVI., which placed the forests under the municipalities, and so delivered them over to their worst enemies.

7. The disastrous effects caused by the torrents have long attracted the attention of men of science, of engineers, and of the legislature. In 1797, M. Fabre, an engineer, wrote a very complete account of the torrents of the Alps, their action, and the means of counteracting them. In 1806, M. Héricart de Thury, in a geological sketch of the torrent country, touches on the same subject. And M. Dugied, formerly préfet of the department of the Basses Alpes, has written an excellent report on the whole question; but it was the terrible inundations of 1840 and 1846 which brought it prominently to notice. A project of law, drawn up in 1843, was reported on by a special commission in 1845, remodelled, and was brought up for legislation in 1848, when suddenly the revolution of February 1848 broke out, and the whole subject was temporarily shelved. On the constitution, however, of the empire in 1852, the forests

shared in the general impulse given to public works in France, and eventually the law of the 28th July 1860 for the reboisement, and the law of 8th June 1864 for the regazonnement of the Alps were passed.

8. The project for the reboisement of the Alps was one based not only on mere speculation, for an operation of the same nature had already been successfully carried out in fixing the moving sands in the Landes of Gascony by the artificial plantations of the dunes or chain of low hills which separates the Landes from the ocean. The whole department of the Landes up to the gates of Bordeaux had been, in the previous century, menaced with destruction by the great moving masses of sand which were continually advancing with measured strides, swallowing up and destroying one tract of land after another. Here the same cause was at work, namely, the instability of the soil, the wind being the moving agency in the Landes, as the water is in the Alps. The work of planting the dunes commenced in 1787, under Bremontier, and with a few exceptions (chiefly between 1789 and 1801) has been carried on with great regularity till the present time, when it is very nearly completed. This line or band of plantations, which is composed of the pin maritime and oak, and extends from the Adour to the Garonne, covers 87,000 hectares (340 square miles), and will, when completed, have cost about 9,000,000 francs (360,000*l.*), an expenditure which has been amply repaid by the fixing of the dunes, and the creation of a forest property estimated at 25,000,000 francs (1,000,000*l.* sterling).* It is perhaps the most remarkable example of successful plantation work on a large scale which forest history exhibits.

9. The original proposed scheme for the reboisement of the Alps involved making over to the forest department the whole extent of lands which it seemed necessary or desirable to cover with forests or pasturage. This scheme, however, was rejected as being too comprehensive in its nature, and was modified by the law of 1860, which limited the action of the department to certain fixed areas, to be taken up especially for the purpose, and which authorized grants of aid in money, as well as in plants and seeds, to communes and private proprietors, who might be willing to work with the same object. Power was, moreover, reserved

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* For an interesting account of the planting of the dunes, see "Maître Pierre," by Edmund About.

by this enactment to enable the Forest Department to adopt compulsory measures, where public interests demanded such interference, or where lands in the valleys were threatened with destruction.

10. This law, however, met with such opposition from the municipalities, who owned the mountain pastures, and who complained, not without reason, of their interests being made to suffer that the property in the valleys might be protected, that in 1864 another law was passed, modifying the action of the previous one. The latter law protected the interests of the owners of pasturage grounds, by substituting in certain cases the regazonnement of the upper slopes of the mountains for their reboisement, a means of prevention against the torrents quite as effective in many situations, provided the grazing was kept under proper restraints.

11. It was estimated that there were in the Alps 1,133,000 hectares capable of reboisements, and that the cost would be 180 francs per hectare. To carry out the work in its entirety would cost then 200,000,000 of francs, or 8,000,000*l*. The law of 1860 sanctioned an outlay of 10,000,000 francs, at the rate of 1,000,000 francs per annum for carrying on the works. At the same rate, therefore, a period of 200 years would be required for the completion of the whole undertaking.

12. After the passing of the law, active measures were at once taken by the executive authorities for commencing operations. A commission of reboisement, consisting of picked officers of the Forest Department, was appointed for the two Departments of the Basses and Hautes Alpes. This commission, which was placed for purposes of general supervision under the Conservators of the Departments, was composed of *one Inspector of Forests*, or "Chef de Commission," entrusted with the organisation of the works, with *one Sub-Inspector*, or "*Garde-Général*," under him, for each sub-division in which work was being carried on. At the outset there were three sub-divisions in the Basses Alpes and five in the Hautes. For the sub-division of Barcelonette, where the work was specially heavy, a second assistant as well as a survey officer were allowed; the total strength of the establishment amounted thus to two principal and ten subordinate officers. This number, however, has varied from time to time according to circumstances and requirements.

13. From 1860 to 1864, the time and attention of the officers were chiefly devoted to the selection of the most

suitable points at which to commence operations; to the demarcation of the reboisement areas, to the making of surveys, and to the submission of projects for execution. The principal sites selected by them were the valley of the Ubbaye, near Barcelonnette, in the Basses Alpes, and in the Hautes Alpes the valley of the Durance, near Embrun There were, besides, minor works near Seyne and Digne in the former, and near Guillestre in the latter department. Until 1867 the plantations were mainly of an experimental character, made in order to ascertain the elevation, exposure, and general conditions which would best suit each kind of tree proposed for the plantations. Since 1867, these points having been satisfactorily settled, the actual work has been carried on with vigour, and up to the end of the year 1870, 79,703 hectares had been laid out either in grass or plantations, the total amount expended on the operations being 10,187,000 francs, or about 400,000*l*.

14. The defensive operations against the action of the torrents carried out by the commission of reboisement may be summed up as follows:

1st. Tracing out and surveying the périmetres or areas of reboisement.

2nd. Planting bands of trees to consolidate the soil on the mountain sides.

3rd. Grassing such slopes between the bands of forests as may be suitable for that operation.

4th. The general regulation of the pasturage.

5th. Planting the "Berges-vives" or landslips.

6th. Construction of dams of masonry or fascine work to regulate the fall of the torrents, and so to check the descent of the débris.

It is evident that all these works must be almost simultaneously undertaken, as their value depends on their united effects, and the aid they mutually give in supporting and consolidating the soil, and so checking the disastrous spread of the torrents. The dams moreover are only for the most part intended to last until the mountain sides, being covered with forests and pasturages, can support themselves, and are in consequence, except in special cases, of a more or less temporary character.

15 The species of trees first employed in the reboisements were the elm, the plane, the Robinia pseud-acacia, and the hazelnut, for soft and crumbling slopes; for hard soils and solid banks the oak and the walnut, and for the moist bottoms of ravines the alder, the poplar, the ash, and the willow. The growth of the black and white thorn, the

myrtle, broom, and brambles was encouraged to cover and consolidate the earth wherever a larger and better kind of tree would not grow. Among the herbs and grasses, sainfoin,* luzerne, clover, fétuque, and bugrane were employed on the regazonnements, but chiefly the common sainfoin of the Alps which will grow nearly everywhere. Trees valuable on account of the quality of their timber were not in the commencement of the work particularly sought after, the main object and aim of these reboisements being to cover the hills with wood as quickly as possible. As the works went on, however, it was found that this could be as well accomplished by the plantation of trees valuable in themselves, and the various kinds of pines were substituted for the trees first employed. It is found that the "pin cembro" succeeds best at the highest elevations and in the most exposed situations. Next follows the larch in hardiness, and this valuable tree now occupies large areas in the plantations. The "pin d'Autriche," the "pin sylvestre," and the "pin noir," are planted in the lower zones, and flourish nearly everywhere.

16. The seeds of the trees are usually sown in the nurseries before the winter snows fall. Occasionally, however, it is done in the spring, the time at which the sowings are made depending on the species sown, the locality of the nursery, and in some instances on the season itself. In some cases the heat, in others the snow, is most to be dreaded for the young seedlings on their first appearance, and all of these conditions have to be taken into consideration before putting in the seed. The planting out of the seedlings, which takes place when they are from two to three years old, is invariably done in the spring.

17. The usual plan followed for commencing the reboisements of the hill sides is to sow the seed in strips of ground 3 or 4 yards in length, and a foot or 18 inches in breadth. These planted strips or bands form little nurseries, from which, as they become sufficiently advanced, the seedlings are planted out on the hillside in the intervening spaces left between the nurseries. There remain, after the planting out is done, a surplus of seedlings in the nurseries;

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* The sainfoin (*onobrychis*) is a plant well fitted to grow on the most arid and barest mountain sides. The fétuque (*festuca*) is better adapted to moist localities. Its deep long roots make it a useful plant in the regazonnements. The Bugrane (*ononis*) from its long and numerous roots is also well fitted to be used in the same way, though from being a prickly plant it is not liked by cattle. It is grazed on, however, by the sheep and goats. The clover and luzerne are well known, and require no description.

these are left undisturbed, and grow up in time, not having space to develope into full sized trees, into thick bushy hedges, which should eventually afford the best possible protection and support to the mountain side. No other water but that given by the natural means of snow and rain is required for the young plants after they are moved from the nurseries; and the most striking thing connected with the reboisements, is to see how the young trees push and thrive on the barest and most inhospitable hill sides.

18. The other works will perhaps be best illustrated by a short account of the reboisements that I visited, especially as I was so fortunate as to be permitted to accompany the special Commission * sent by the French Government to report on them, and heard all important questions connected with them discussed and explained on the spot by the officers in charge.

19. Between Digne and Seyne (in the Basses Alpes) two perimètres were visited of 113 and 100 hectares each, and at Seyne itself a large perimètre of 4,500 hectares. Three days were spent in visiting these works, which are a fair average specimen of the preventive measures adopted in the Basses Alpes. Bands of pines, oaks, and Robinias are planted to cover the hill sides, the broad intersecting spaces being grassed over with sainfoin and fétuque; while in the ravines barriers of masonry and fascines regulate the descent of the torrents and check the washing away of the earth. The perimètres or planted areas are well provided with roads and paths, which enable the workpeople readily to get about them, and when necessary the enclosures are fenced in with wire. These plantations were among the first formed in the Basses Alpes, and portions of them are at least seven years old. All are doing well, and are flourishing.

20. It was here that I first saw the remarkable use made of barriers of fascines to support the crumbling sides of the landslips (berges vives). These barriers of fascines (called after their inventor "Barrages Jourdan,") consist of rows of fascines placed horizontally across the small ravines which feed the torrents, and kept in their places by other fascines fixed vertically so as to bind them together. These barriers are placed every 8 or 10 feet down the ravine, and if composed of green wood such as willow, will often send out

* The Commission was composed of M. Nanquette, Director of the Forest School, as chief, and M. Bagneris, professor of amenagement, in the same institution, as a member.

roots and shoots, forming themselves into living hedges at intervals across the landslip, and supporting the earth so that the intermediate spaces can be planted with trees. Wherever fascines are not suitable, or easily and cheaply made, rough walls or dams of rubble masonry are substituted, and appear, if the earth is tolerably firm, to act as well, the main object being to support temporarily the earth until the surface of the landslip be planted. This in almost all cases has been most successfully accomplished. M. Jourdan, who was a simple forest guard, was deservedly rewarded for his excellent practical invention by the gold medal of the National Society of Agriculture of France, the greatest honour of the sort that can be conferred on anyone.

21. After leaving Seyne, the great reboisement works near Barcelonnette (the head-quarters of the Basses Alpes division) were visited. Three great torrents here spread devastation over the valley of the Ubhaye; two of these, le Bourget, with its affluent, les Sanières, lie to the north-east of Barcelonnette, while the third (the great torrent of the Riou Bourdoux) of which the "cone de déjection" measures above three kilomètres in breadth, sweeps the hills to the north-west; all have their origin in the range of mountains which runs between Barcelonnette and Embrun.

22. The works laid out for counteracting the effects of the torrents of le Bourget and les Sanières extend over an area of 8,000 hectares, and are carried to an altitude of over 7,000 feet above the level of the sea. The roads alone through the plantations have a total of 32 kilomètres. The main immediate defence against the torrent consists of two great barriers in masonry. The one, made of immense blocks of dry rubble, is placed half way down the canal d'écoulement of le Bourget; the other, of solid masonry set in lime, stands nearly at its foot. This last is a huge work, and reflects the highest credit on the officers engaged in its construction. Commenced in August 1872, it was finished in June of the present year; it is 90 feet in length, 44 feet in height, and contains 27,545 cubic feet of the most powerful masonry set in hydraulic lime. Many of the stones must weigh upwards of half a ton weight, and the whole work is of the most solid nature. Its cost, which was only 13,706 francs (548*l.*), must, as compared with the rates which prevail in India for masonry of the same class, be considered very low.

24. These barriers are again supplemented by innume-

rable smaller ones, both in fascines and rubble masonry, and an examination of the localities will at once convince the most casual observer that the protective measures adopted are thoroughly sufficient to check all further erosion of the hill side. At the same time further works of a permanent character are projected for the bed of the torrent, to regulate the slope, while the plantations now made on the hill sides above it are coming to maturity. These plantations consist of bands of the pin cembro near the crater of the mountains, below which come bands of larch (melèze), succeeded at a lower level by the pin noir and pin Sylvestre, the intermediate slopes between these wooded bands being grassed over with sainfoin. The landslips (or berges vives) below the canal découlement are being treated in the manner already described for those at Seyne. (Para. 20.)

25. The cost of the reboisements in the Basses Alpes is estimated at 300 francs per hectare, inclusive of all expenses for surveys, roads, fencing, and other works, besides the actual nurseries and plantations, during the four years which it usually requires for the young trees to become so advanced as to demand no further outlay. As the plantations grow up the thinnings will soon begin to cover all outlays. The roads on the plantations cost about 1,000 francs per 50 hectares, or 60 centimes per running mètre. Rough wire fencing costs about 90 centimes per running mètre.

24. After leaving Barcelonnette, some small perimètres of reboisement near Larche, made to protect the road into Italy, which crosses the Col de l'Argentière, were visited. These presented no features of particular interest, and after crossing the Col de Vars the Commission visited the reboisements above Guillestre, in the Hautes Alpes. These are of very considerable extent, and include many large barriers of dry masonry, with a large area of reboisement; but a repetition of detail is unnecessary, the works in the Hautes Alpes not differing as regards main principles from those in the valley at Barcelonnette.

25. I cannot conclude this paper without remarking on the professional skill and ability with which these operations are carried out; also on the care and watchfulness exercised by the officers in charge over all items of expenditure, and the generally low rate at which the works are well carried out. To the Indian forest officer a visit to these localities must, from the great resemblance between the French Alps and the Lower Himalaya, both as to their

geological formation, general aspect, and physical condition prove specially interesting.

27. I may add that any officer visiting the torrents should study Surell's able work on the subject; and I can best conclude this paper with his remark, "That the "longest explanation can give no adequate idea of the "way in which these scourges of the mountains must be "treated. One visit to *one* perimètre of reboisements will "give a better idea of what must be done, and of the effi- "ciency of the means of cure now being applied than the "study of hundreds of written pages."

CHAPTER III.

The Forests of the Jura.

The Jura consists of a block of mountains lying between Switzerland on the one side and the valley of the Saone in France (the Franche Comté) on the other, characterised by a series of long parallel valleys running north-east and south-west, intersected by short deep cuts crossing them at right angles, and has been formed by a succession of violent convulsions, which have heaped up the beds of clay and lime-stone rocks so as to form three steps or plateaux rising above each other from west to east, and having their scarped side towards Switzerland. Towards France their slope is regular and gradual. The highest peaks, which are all on the Swiss side, attain an elevation of from 1,700 to 1,800 mètres (5,700 to 6,000 feet) Though the geological formation is different, the general contour of the Jura is strikingly similar to that of the Puchmurrees in Central India.

2. The climate of the whole of this tract of mountains is exceedingly moist. The Jura owes this to the accident of its situation, between the mass of water in the Swiss lakes on the one side, and the low lying valley of the Saone, intersected by numerous watercourses and covered with marshes, on the other. The masses of vapour drawn up on either side are attracted by the forest covered hills between them, on which they pour down in the shape of constant rain. The vegetation is consequently exceedingly rich, a richness which is owing rather to the climate than to the soil; the forests are superb, and the pasturages are renowned throughout France.

3. Each of the three plateaux is characterised by a peculiar vegetation. At the foot of the mountains, at Arbois, we find the vines flourishing in rich luxuriance on the lias. On ascending to the first plateau the oak, mixed with ordinary cultivation, is found everywhere, but the vine disappears. On the second plateau, we lose the cultivation to a great extent, the pasturage, mixed with vast forests of silver fir taking its place, and the spruce fir being mingled with the sapin in the upper parts of the plateau. The spruce fir is the characteristic tree of the third plateau, on which cultivation may be said to cease entirely.

4. Among the most interesting of the Jura forests are the Communal forests of Pontarlier and the Forest of Levrier near Boujeailles, both on the second plateau, and the spruce forests around the Mount d'Or, especially the forest of the Grand Côte, on the third plateau; some of these will now be described.

Communal Forest of Pontarlier.

5. This fine forest is situated close to the town of Pontarlier, on the slopes which lead from the second to the third plateau of the Jura. It is composed partly of silver fir (sapin) only, and partly of silver fir mixed with the spruce (épicéa). Situated at an elevation of 3,000 feet above the sea, the climate is very severe, but being at the same time moist, the general conditions for vegetation are so favourable, that it is hardly possible to find anywhere a more magnificent forest.

6. The forest is divided into two working circles or series of blocks regulated to the same rotation. It is, moreover, as is often the case in the Jura, cut up into separate belts by bands of pasturage. The first of these working circles (named the Bois-dessus) which was examined by the pupils, contains 232 hectares (about 600 acres) divided into five working blocks or affectations. The period of rotation is fixed at 150 years, divided into five "periods" or subdivisions of 30 years each. The whole is managed under a system of jardinage, and is well worthy of study as an example of the perfection to which that system may be brought under good management, where the condition of the forest, as well as its annual revenue are kept in view. The whole is a high timber forest, the trees in each block presenting wonderful regularity in respect to age, and all thoroughly flourishing and in good order. A portion of the lower or Eastern side of the forest is perhaps the most magnificent

specimen of a young timber forest of spruce and silver fir that I have seen in France. Some of the trees are of remarkably fine dimensions; one young tree measured by the pupils was found 28 inches in diameter, and 108 feet in height of workable timber. It contained about 6 cubic mètres (210 cubic feet) of timber, and was valued as it stood at 120 francs.

7. This forest, worked strictly according to the working plan, has during the last 15 years yielded at the rate of seven cubic mètres or 245 cubic feet (English) per hectare, giving a total revenue of 26,500 francs, equal to 115 francs per hectare, or 46 francs (1*l.* 17*s.* 6*d.*) per English acre. The annual amount of the wood taken from the forest has been 1,700 mètres, or 60,000 cubic feet.

8. In the Jura timber is divided for purposes of sale into three classes, the silver fir and spruce being for all practical purposes valued alike. The first class consists of logs 28 inches and upwards in diameter, and is valued at 23 francs per cubic mètre of 35 cubic feet. The second class consists of logs from 20 to 28 inches in diameter, and is valued at 20 francs per cubic mètre. The third class consists of logs from 12 to 20 inches in diameter, and fetches 18 francs per cubic mètre. All trees are sold standing in the forest; and all below 12 inches in diameter are sold as poles.

Forest of Levriers.

9. The forest of Levriers is situated on the slopes between the first and second plateaux of the Jura, not far from the station of Boujeailles, on the line which leads from Besancon, by Mouchard, to Pontarliers and Neuchatel. It is a forest belonging to the State, and covers an extent of 2,723 hectares (6,812 acres or about 11 square miles) divided into belts or strips by alternate bands of pasturage. It is a pure forest of silver fir, the climate and general conditions of vegetation being thoroughly suitable to that tree, though not to the spruce (epicea), which requires a ruder climate and a moister soil, and which is consequently hardly to be met with here.

10. The forest of Levriers belonged formerly to the House of Châlon, from whom it was taken by William of Orange, to be recovered again by the successors of Charles V. In this way it passed, about 200 years ago, into the possession of the crown of France, and now forms a part of the State domain.

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11. It was managed formerly on a system of jardinage, different rates of felling prevailing in different blocks of the forest, according to their supposed capability. In some parts this rate was one tree per annum per hectare, in other parts, a tree and a half per annum, the forest being divided off into 20 cantons or compartments, one of which was worked annually, so that after each block had been worked, it was allowed to rest during a period of 19 years. Generally speaking, this rate was far below the producing rate of the forest, and for several years it has been found possible to remove from the ground timber to the extent of 10 cubic mètres per hectare for the whole extent of the forest, and this without committing any imprudence. This high rate, however, could not be maintained at present, had not the forest been allowed to overgrow itself in past years, and the present generation is profitting by the sparing and cautious felling of its immediate predecessors.* It was, however, probably owing rather to the difficulties of communications and of finding a sale for the wood at that period rather than from any direct act of prudence, that more timber was not felled in the early years of the present century.

12. At present the greater part of the forest is undergoing a conversion from the system of jardinage to the regular system, by the removal of the larger trees, as well as those of irregular ages in the different compartments, many of which now present an extremely regular appearance. Eventually, when brought completely under the regular system, the forest will yield a larger ratio of timber than it ever could have done under a system of jardinage.

13. Some of the trees in this forest are of magnificent dimensions. Two trees, which had been just felled, were measured by the students, and were found to be 36 and 32 inches in diameter respectively, and 132 and 137 feet in length, of which nearly all was wood fit for working up into various constructions. Anyone visiting the Jura should not fail to go and see the Forest of Levriers.

14. From Pontarlier a very pleasant excursion may be made through the forests of the third or upper plateau, around the foot of the Mont d'Or, taking care to visit the splendid young spruce forest of the Grand Côte. On this

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* Ten cubic metres per hectare represents 350 cubic feet per hectare, or about 1,000,000 cubic feet for the whole forest, giving an annual revenue of 555,000 francs (22,000*l.*), or at the rate of rather more than 200 francs per hectare, equal to 80 francs (3*l.* 4*s.* 3*d.*) per English acre.

plateau, beautiful alike for its forests and its scenery, the spruce fir (epicea) finds its real home. The number of small lakes, which abound everywhere, combined with the great elevation (between 3,000 and 4,000 feet) render the climate excessively cold, and at the same time moist, conditions which thoroughly suit this tree. The forests are consequently magnificent. In winter the storms are excessively severe, and it often happens that bare spaces of several acres in the forest are left to testify to the violence of the winds, which have overthrown the trees. Around the Mont d'Or itself, from the summit of which there is a magnificent view of the whole chain of the Swiss Alps, the forests cease entirely. Pasture and stunted bushes take their place. Large herds of cattle, however, during the summer months find admirable grazing all over the plateau, and an immense quantity of the cheese, for which the Jura is so celebrated, is made and exported every year. In its forests and in its pastures, indeed, consists the whole wealth of the country.

CHAPTER IV.

Vosges Forests (Gérardmer).

Gérardmer is a large village in the heart of the Vosges, lying around the shores of a small lake, and surrounded by fine forests. It is celebrated also for its saw mills, and extensive manufacture of the Vosges cloth. It may be reached either from Remiremont or Laveline, to both of which places there is a branch railway line, leaving the main Nancy and Vesoul line at Epinal.

2. The State forests of Gérardmer extend over some 4,500 hectares, the Communal Forests over 830 hectares, and there are about 600 hectares of forest land belonging to private parties. The total extent then of the forests round Gérardiner may be estimated at 5,990 hectares, or nearly 15,000 English acres.

3. These forests are peopled mainly by the silver fir or sapin (*Abies pectinata*), the spruce or epicea (*Abies excelsa*), the beech or hêtre (*Fagus sylvatica*).

Intermixed with these trees are found several sorts of other secondary species, besides shrubs; but their growth has no influence on the yield of the forests.

4. The silver fir and spruce differ little, either in appearance or habits, from those that are found in the Himalaya. Their timber appears also to me to be much of the same

quality, and would probably, if exposed to an Indian climate, not prove superior in durability. The yellow hanging moss, which in the Himalayas grows exclusively on the spruce, is found in the Vosges constantly on the silver fir.

5. The beech, which formerly held an important position among the trees of these forests, has been for many years gradually diminishing in numbers, and in some districts has entirely disappeared. This is attributable partly to its value as a fire wood, which has caused the trees to be greatly overfelled, and partly to the moisture of certain portions of the forests, which favours the growth of the spruce fir, to the detriment of the beech. The ease too with which the spruce is reared in artificial plantations has caused it to be resorted to for the filling of bare spaces in the forests. It may now be considered as holding the first place in these woods, and after it, the silver fir.

6. As a rule, the spruce of the Vosges forest is a taller tree than the silver fir; this last, however, is the thicker of the two, so that the individual yield of both is about equal, as also their market value. There are more solitary fine specimens of silver fir. One of these, known as "Le Gros Sapin," measures 179 feet in height and 25 feet in circumference. There is an idea that the wood of the silver fir is the best adapted for planks, and that of the spruce for scantlings; but practically no reference is paid to this distinction in working up the timber, which is applied indifferently to either purpose.

7. The produce of these forests may be set down in round numbers at 36,000 stères annually, of which one fifth is beech. About 5,000 stères of the remainder are fit only for firewood. 24,000 stères are converted into planks and scantlings, in the proportion of some three fourths of planks and one fourth of scantlings.

8. The planking is cut up entirely in the numerous saw mills found all around Gérardmer. Indeed, had all these saw mills been constructed on principles which kept in view the necessity of economising the water supply, and of turning it to the best advantage, they could cut up far more wood than the forest could yield. As it is, there is constantly a scarcity of water, which prevents the mills working to full power. During the winter the forest roads are so heavy that it is often extremely difficult to carry out the wood after it is cut up; so that even if there were more planks ready for transport, their removal would be almost impossible.

9. One stère of timber in log produces 20 planks of the uniform marketable size. The planks are always cut to one size, being 12 feet in length, 6 inches in breadth, and 1 inch thick. This thickness is in some measure reduced by what is lost in sawing, and that varies again with the thickness of the saw and the manner in which it is set.

10. The rate of sawing in the Vosges mills is 95 francs per 1,000 planks. Half of this sum goes to the proprietor of the mill and half to the workmen. The number of planks turned out per year is about 420,000. If the mills were kept constantly at work at full power, they would give a yearly out-turn of 820,000. They cannot, however, be uniformly worked to the fullest extent, and the number of planks sawn up varies every year according to the drought or damp of the season.

11. The converted wood, planks and scantlings alike, is exported by the forest roads to the various railway depôts of the neighbourhood, whence it finds its way to the markets of the country side. There are at present no rivers or canals available for its transport, and the market for its sale is therefore somewhat restricted. When the canal (now under construction) is finished, which is to unite the Moselle to the Saône, a sale for the wood of the Vosges forests will be doubtless found in the markets of both the north and south of France, and it will reach even Paris and Belgium. The firewood is all consumed at home, and is indeed actually insufficient for the wants of the population, who make use besides of peat from the morasses in the hills, and work out of the ground the stumps of the felled trees.

There are numerous factories scattered all round the base of the Vosges where wood would be employed for fuel, could it be obtained at a low rate.

12. The only manufactures in this part of France in which wood is the staple article employed, are those of paper and cooper's work. In the paper mills the wood is crushed by machinery, and then reduced by certain chemical processes to a paste; this, after being mixed with a proportion of rags, produces eventually a very fair description of paper. The cooper's work consists of ordinary casks, tubs, measures, &c.

13. Several of the saw mills are exceedingly well worth the attention of forest officers from India. I should especially mention the one known as "M. Canzon's wheel." It is a direct action vertical wheel, the great simplicity of which renders it peculiarly well fitted for use in an Indian hill

forest. This wheel is made entirely of wrought iron and wood, and is driven at an enormous speed by a jet of water of no great volume, but falling from a considerable height (about seven mètres). The shaft, as it revolves, drives the saw to which it is directly fastened. The beauty of this arrangement consists in the combination of speed and power in a wheel which acts immediately on the saw. Any one interested in forestry and its concomitant timber operations may spend 10 days or a fortnight very usefully and agreeably at Gérardmer, where comfortable quarters are to be had at Madame Reiterhart's hotel.

CHAPTER V.

The Forests of Remiremont (Vosges).

Remiremont is a small town at the foot of the Vosges, below their western slopes. There are several forests in its neighbourhood worthy of being visited, especially the Communal forests of Remiremont, the forest of Val d'Ajol, and the forest of Hérival on the road to Plombières.

2. The structure of the hills around Remiremont is granitic. In leaving the town, to visit the Communal forest of Remiremont, a large compartment of spruce fir (epicea), artificially planted is first entered. But the elevation is not sufficient for this species of tree, which in this latitude (48° north), does not prosper under 750 mètres (2,500 ft.) above sea level, while Remiremont is scarcely 1,500 ft. As the forest advances in growth, the spruce fir will probably be replaced by the natural production of silver fir (sapin), a forest of which is found immediately above it on the hill side, and which will thrive perfectly well at this elevation.

3. On mounting the hill we enter the natural forest of silver fir. This is now worked under a system of "jardi-" nage," which consists in "the selection of trees for felling "from all parts of the forest simultaneously." From this, it results that the forest contains trees in every stage of growth, and has therefore that irregular appearance peculiar to forests worked under this system. Certain parts of the forest are however more regular than the rest, in proportion as they have been more freely cleared of the old, decaying and mature trees.

4 A striking example may be seen in this forest of the way in which the silver fir will tolerate the cover of larger

trees, even till an advanced stage of its growth. Trees of even 60 years of age may be seen here, overtopped by their elder brethren, and yet doing well; while where they have been freed from this shade, they may be seen shooting up at once with vigour, and expanding themselves. In this peculiarity the silver fir of Europe in no way differs from the tree of the same species found in the Himalayan forests.

5. In parts of the forest we find some deciduous trees, especially a number of oaks (chêne pédonculé) along the streams and plains, all of which are doing well, the elevation of the forest not being too great for them. Their presence in the forest is a great advantage, as assisting to keep the ground fresh, and they should be carefully preserved.

6. This forest has been much attacked by the disease, peculiar to the silver fir, known in France by the name of the *chaudron*, or swelling of the trunk (entasis). The chaudron, which is much more common in certain forests than in others, results from a stoppage in the sap, which first shews itself by the production of a deformed bushy excrescence or bough, called in the Vosges "o balai sorcier." or the sorcerer's broom. This deformity, and the subsequent swelling in the trunk of the tree, are due to the development of the fungus growth or champignon on the stem. As the chaudron becomes developed, the bark of the tree becomes split up, and partially stripped off, permitting the sap to run away. The wood in this spot then becomes of a reddish color, soft, of a spongy texture, and partly carious, the woody fibres being interlaced, and very irregular. The consequence of this is a fault or weak spot in the tree, which renders it exceedingly liable to break off while yet standing. If this however does not happen, the flaw or weak spot in the wood still remains, which renders the log unfit for use, and therefore greatly depreciates the value of the tree for all purposes for which considerable length is required.—(Fliche's Botany.)

7. Generally speaking, the young trees in the Communal forest of Remiremont are thoroughly healthy, and the forest is in good condition. On the top of the plateau, however, which is covered by a mixed forest of beech and silver fir, the trees have been too much opened out by felling, and the wind having got in among them has overturned many, so that a large portion of the summit of the hill has been laid bare.

8. *The forest of Val d'Ajol* contains about 1,800 hectares,

and is composed partly of deciduous, and partly of resinous trees. It is situated on a soil formed from the decomposition of granitic rocks, chiefly of porphyry. These rocks are found largely in the Vosges, chiefly however on the side of Lorraine. The forest is managed on the system of jardinage. It contains a fair number of trees of mature age, and generally speaking is well peopled with those of all stages of growth, which will do well if care be taken to leave on the ground a sufficient number of large trees for seed purposes, and to protect the younger ones from the snow, which here falls heavily. There is plenty of moss also in the forest which keeps the ground moist, and the soil fresh, and in good condition for vegetation.

9. In the Cantons of Rebas and Martin may be seen an unsuccessful attempt to convert a forest of mixed oak coppice, intermingled with some silver firs, into a pure forest of silver fir. To effect this the oak was cut away entirely, and its place was filled by the artificial plantation of the silver fir. The soil however is not suitable to this tree, and it is not doing well; while the forest is reproducing itself in the form of an oak coppice which is everywhere springing up again. The result therefore has been in every way an unfortunate one.

The Forest of Hérival.

10. This forest, which is on the road from Remiremont to Plombières, is divided into two portions. One of these belongs to the Commune of Vecoux, having been made over to that municipality in order to disencumber the rest of the forest, which belongs to the State, of all extraneous rights. It is a mixed forest of beech and silver fir. The beech here is doing well under the silver fir, and there will be no occasion to proceed too hastily to the final fellings on that account, nor will it be necessary to give more room to the young silver firs, whom on the contrary the beech will protect from injury from the heavy falls of snow.

11. The portion of the forest which belongs to the State covers an area of 508 hectares in one block. It is at present under jardinage, but is being converted into a regular forest. The period, however, allowed for the conversion (120 years) is considered by the officers connected with the forest as somewhat too short; and it is proposed to extend it to 150 years, due regard being had to the condition of the forest and the species of trees which compose it. This

forest is one which may be studied with advantage for the purpose of learning the system of conversion of mixed forests from the jardinage to the regular system.

CHAPTER VI.

The Forest of Haye.

This forest, which is situated in the immediate neighbourhood of Nancy, is a mixed coppice forest of oak, beech, and hornbeam, covering an extent of 6,523 hectares (16,208 English acres, or 25¼ square miles nearly). Always known by the same name, it belonged in ancient times to the Dukes of Lorraine, and passed into the possession of France by the treaty of Vienna in 1738. Since then some comparatively small additions have been made to it, such as the forests belonging to the Abbey of Clarlieu, which became part of it at the Revolution of 1789; and la Champelle, and Les Hayes, two small forests which belonged formerly to Thiébault, Marshal of Burgundy. Some small portions of the forest have also from time to time been sold or exchanged. But as regards nineteen-twentieths of its area, the forest remains now the same as it existed formerly. The forest is placed for all purposes of management under the Director of the Forest School, who is ex-officio conservator of it.

2. The forest is divided into five main sections, of which the two principal ones lie to the north and south of the road from Nancy to Toul, which runs directly through it. The three minor divisions are those of the forest of Toul, to the north of the above-named road, the Canton Grande Fraise to the south of the road to Lyons, and the Canton Convers to the east of the last-named Canton. The entire block as above described lies in the angle formed by the confluence of the Moselle and the Meurthe.

3. The plateau on which the forest lies has a mean elevation of 350 mètres (1,120 feet) above the sea level with a general elevation of from 450 to 500 feet above the valleys of the Moselle and the Meurthe. Composed as it is of an oölite formation, in which are found numerous vertical fissures, the plateau itself is dry and devoid of moisture, and the soil of the forest which is very shallow is naturally ill-

adapted to favor vegetation. Hence the primary necessity of keeping the soil covered with a thick coat of dead leaves, which may help both to add to its fertility, and keep it moist and fresh.

4. The surface of the forest is undulating, intersected by numerous ravines, running down to the Meurthe and the Moselle. This broken nature of ground, forming numerous slopes and steep banks, is the cause of the great differences observable in the vegetation of different parts of the forest, lying in close juxtaposition with each other. Generally speaking the vegetation is stronger and better on the eastern and northern slopes than on the southern and western; and the young seedlings, especially those of the beech, suffer more from the early frost and hoar frosts in the low valleys and ravines, than in the more exposed situations.

5. Of the two species of oak which form component parts of the forest, the chêne rouvre succeeds better on the dry, stony, shallow soil which is found there than the chêne pédonculé. Both, however, grow to a fair size; and at the age of from 140 to 160 years furnish timber sufficiently good for ordinary purposes, though hardly so for the purposes of ship building. The beech, however, of which there is a larger proportion in the forest than the oak, grows well. In its earlier years its increase is slow, but from 40 years and upwards it takes rapid strides, and at 100 years old there are many trees containing more than 100 cubic of timber, and which are at least 90 feet high. Moreover, it is long lived, and trees may be found frequently among the reserves of the forest which have attained the age of 175 or 200 years without showing any symptoms of decay. The hornbeam, which forms the greater portion of the coppice, is only kept as a reserve, where the beech is wanting. For all purposes, except as firewood, it is useless for timber. It has been most useful, however, from the thick shade which it gives, as well as from its tendency to spread itself, in keeping the soil of the forest in good condition.

6. Generally speaking the present condition of the forest will be found as follows:—

In certain places where the reserved trees of oak and beech are too close together, the coppice is weak and poor from being too much under shade; in other places, where the reserved trees are more widely spread, the coppice is doing well. This coppice is nearly everywhere composed

of beech and hornbeam. In others where the reserved trees are too few, the coppice of hornbeam has entirely usurped the ground. In parts of the forest, where some fellings with a view to its conversion into a high timber forest were made between 1832 and 1838, may now be found thickets of high poles of beech and hornbeam from 60 to 70 years old, in fair condition and doing well. Such is the present condition of the forest.

7. The whole of the firewood which the forest of Haye produces finds a market either in Nancy or its neighbourhood, for the full supply of which it does not suffice. The timber of large size which the forest produces, both oak and beech, is for the most part converted into planks and scantlings in the saw mills of Nancy, where a portion of it finds employment, the rest being sent for sale to Paris.

8. The revenue of the forest for the 10 years from 1850 to 1860 averaged 243,000 francs. But when in 1859 it was handed over to the forest school at Nancy, provision was made that at first not more than 200,000 francs per annum should be required to enable certain operations absolutely necessary for the well-being of the forest to be carried out. These are now in progress, and it is hoped that the revenue will shortly rise to its former mark without any injury accruing to the forest.

9. From what has been said above it will be seen that at present the produce of the forest is but small. As regards the small wood its yield does not exceed two cubic mètres, valued at 29 francs per hectare per annum. The fact is that the soil is not well suited to grow coppice. Poor in itself, and from its geological formation always too dry, the soil requires a constant covering of thick leaves to preserve it fresh. This is inconsistent with a system of coppice, as for long successive periods the ground is to a large extent uncovered, and remains so after the coppice is cut until it grows again. This also acts on the reserved trees which do not attain the size, nor yield the quantity of timber they would do, were the soil continually maintained in a state of freshness. It is probable that if the forest were converted into a high timber forest, the annual yield would be raised from two, to between five and six cubic mètres per hectare per annum, and that the annual product would in consequence be more than doubled. This is the direction in which the efforts of the officers in charge of the forest are working. There can be no doubt as to the soundness of

their views, and Indian officers visiting Nancy will find in the forest of Haye a constant subject of interest in watching the measures which are being taken to effect this object. An adequate account of these interesting works would occupy too large a space to admit of their finding a place in a report of this description. Moreover, without some knowledge of the ground and of the trees composing the forest, it would hardly prove intelligible. But as the general principles which regulate the management of coppice differ little anywhere, and as a forester of experience will readily be able to tell what parts of the work he sees in other countries are applicable to his own, a careful study of the management of oak and beech coppice is strongly recommended to officers coming from India to study forestry in France. This study can nowhere be carried out so well or so readily as at Nancy, inasmuch as the forest of Haye is used as a special place of instruction for the students of the forest school, and the records of the operations carried on there are kept specially with a view to that end. Added to this the professors of the school are those charged specially with the operations in the forest, and are always ready to afford information and assistance on any subject to those requiring them. There are several forests on the eastern side of the Vosges, which can easily be visited from Nancy, and which will be found most instructive. Among these may be mentioned the State forest and the forest (Communal) of Strassburg in the Hohwald Valley, and the Communal forests of Barr and Obernai near St. Odile. Capital accommodation and every convenience may be found in the excellent hotel at the Hohwald, and in the convent or hostellerie of St. Odile. These places are approached by the line which leads from Strassburg to Barr. By the Wasselonne branch of the same line the oak forests of Westhofen near Wasselonne, and the fir and sapin forests of Mosingthal (Canton Steinlaeger) between Waugenberg and Obersteigen, some of the finest of their class, may easily be reached. The Schlitts or timber slides and the whole system of timber transport in the forests on the eastern side of the Vosges may be studied with great advantage I do not possess the details which would enable me to describe these forests at length. Indeed it is not necessary, as I have already given a full account of forests of the same class. I can only repeat, what I have said before, that any forest officer who can give sufficient time to the subject will find himself repaid if he will take up his

quarters at the Hohwald or St. Odile for a few weeks; when spending his days in forest, he will naturally be able to study them for himself. Nowhere in the world will he find more lovely woodland scenery, and nowhere a more agreeable climate if he only go there at the right time of year. The Vosges are unlike both the Alps or the Himalaya, and the visitor must not expect to find among them the grandeur of those great mountains. But they are unique in themselves, and very beautiful, and with the beautiful Rhine valley at their feet, form a country of which the Alsaciens may well be proud.

H.

Report on the transport of timber from the hill forests by means of *wooden tramway* and *wire rope slip* as carried out by Herr König near Alpnach in the canton of Unterwalden, Switzerland; by Captain Campbell Walker, Staff Corps, Deputy Conservator of Forests (Madras).

The tramway and wire rope slip which form the subject of this report are situated in the vicinity of the village of Alpnach on the lake of Lucerne. The village is about one mile distant from the landing stage from which the trip to or from Lucerne does not occupy more than an hour.

My attention was first directed to the subject by Dr. Brandis, and I found a model of the tram and slip in the Swiss Court at the Vienna Exhibition. I likewise procured a "brochure" describing the arrangement compiled for the Forest Department of the canton of Bern by Forstmeister Fankhauser, and it is to this publication that I am indebted for the measurements and other data given in this report, and for the drawings which had been lithographed in Bern and which I have re-arranged and re-produced with the kind permission of the author.

On my way home from Vienna I took the opportunity of visiting the spot and personally inspecting the arrangements which require to be seen to be fully understood.

The proprietor and inventor gave me every facility for inspecting the tramway and slip, and making myself thoroughly conversant with the mode of construction and working. His son accompanied me as guide, and as he had himself helped to make the line, was well able to impart information. For the guidance of any forest officer who may hereafter visit the place, I think it well to state that it is a good day's work to inspect the whole arrangement I started at 6 a.m., and did not get back until 4 p.m., including an hour's rest at the top of the line where the forest is situated. Some light refreshments should be taken, and if the visitor is not a good walker, it would be well

to make the ascent so far as practicable on horse back. Of course two or three days might be profitably spent in watching the working, and becoming fully conversant with the details; and if time was not so much an object as it happened to be in my case I would recommend the visitor if connected with the forest service to communicate with the head of the Government Forest Department at Bern, who would I feel sure do his best to help him to see this and other means adopted for the transport of timber in the neighbourhood. There are also I was informed some saw mills in the canton worth a visit, and doubtless much to be learnt from the local circumstances (so far as regards situation at least) somewhat resembling those of our Indian Hill forests.

I proceed to describe as briefly as possible:

1st. The wooden tramway which brings the timber from the forest to the upper end of the wire rope or cable and may again be employed at the foot of the slip.

2nd. The construction and working of the slip itself.

In the year 1870 Herr König purchased a tract of forest in the canton of Unterwalden situated to the south-west of the valley of the little Schlier and almost equidistant from Kaltbad, Scheinberg, and Pilatus. Its extent is 275 English acres of which 175 may be considered as fully stocked with timber, chiefly spruce, a great proportion of the trees being not only mature but even *back going*, that is, deteriorating from old age.

The forest being situated at a height of 4,300 feet above the level of the sea, and the ascent from every direction being steep and rocky, rendered the construction of a road for removing the timber matter of great labour and expense, so much so that the idea could not be entertained. Neither was there any opportunity of floating the timber, the only streams being mountain torrents rushing down steep and rocky gorges when swollen by the melting of the snow on the higher hills and at other seasons leaving their beds almost dry.

On account of these difficulties which had hitherto prevented any attempt at working the forest Herr König

N B – All the measurements, weights, amounts, &c having been given in the French and Swiss measures, &c., *e.g.*, mètres, kilogrammes, and francs, I have reduced them into the corresponding English weights and measures as accurately as possible, which will account for some of the measurements appearing peculiar and pedantic to an English reader.—C W

obtained the right to fell and remove as much timber as he could in 12 years for the comparatively small sum of 2400*l.*, the yield being estimated at about 300000 cubic feet, but this estimate is considered as very favourable to the purchaser, Herr König, who appears to be a most enterprising man and had already made use of the wire rope in a small scale for the transport of timber to his saw mills at Bettenwyl (canton Bern) at once determined to make use of that means here, and as the forest itself is situated on the edge of a plateau extending northward and eastward for upwards of three miles with an easy gradient, decided to supplement the wire slip by a wooden tramway which should transport the logs to the top of the slip being itself fed by short lines or branches laid down as required into the portion of the forest where felling was going on.

The construction of this tramway and putting up the wire rope occupied upwards of 12 months' hard work, the whole planning and arrangements being made by König himself aided by his two sons. When it is borne in mind that none of the three had any training as engineers or even mechanics, and that the father was never even at school, it appears indeed marvellous that they should have succeeded in constructing such a practical and useful *road*.

The permanent tramway may be considered as 3 miles in length, running in a north-easterly direction along the northern side of the Blanenberg from the outskirts of the forest to an open meadow known as the "Eggbrünnen," where the wire rope commences, the trollies or waggons carrying the timber running right underneath it so as to admit of the log being raised direct by chains on to the rollers (Plate I.). From the upper end, or what we may call the departure station of the tramway, there are at present two branches leading into the forest, one descending rather abruptly to the westward and the other running with a very slight gradient for about one mile in a northerly direction round the hill side (Plate II.).

The main line has a fall of about 18 per cent. for nearly three-quarters of a mile from the departure station after which the remaining distance to the Eggbrunnen has an average fall of 4 per cent., with the exception of one portion where there is a slight rise.

There is a small portable engine at the departure station which was formerly used for drawing up the empty waggons, but when I visited the place it was not working, and I imagine was found of little use. It is stated to have cost only 60*l.* By a simple arrangement the laden waggons

starting down the main line are made to pull up others from the western branch when that portion of the forest is being worked; to effect this they were merely connected by a wire rope or cord, costing about 6*d.* per running yard, which runs on small rollers in order to decrease the friction. The rollers are fastened to the sleepers in the centre of the road (Plate III.). I think this plan might be more generally introduced and adapted to the drawing up of the empty waggons from the arrival station, whence they are now pushed up by the workmen with much labour and waste of time.

The tramway is laid on two different methods, which are adopted according to the nature of the ground traversed; the whole road, including what we may call the *rails*, is constructed of fir wood, the only iron work being screws and nails securing the pieces together and fastening the wooden rails to the sleepers. These nails even might in most cases be made of hard wood. The gauge of the line throughout is a little under three feet (90 centimètres = 35·433720 English inches).

The first method (Plate IV.) adopted in constructing the *way* is to lay down sleepers at a distance of from 10 to 15 feet apart, and on these to run the longitudinal sleepers or wooden rails along which the waggons are to run, securing them by nails and wedges, or more technically *keys*. The length of the rails varies from 20 to 30 feet, and they are obtained by felling trees of about 1 foot in diameter, and sawing them through lengthways; all this was performed by hand sawyers on the spot. To lay down the description of road, it is necessary that the ground should be pretty regular and more or less prepared beforehand. It is estimated to cost about 1*s.* per running yard without including cost of the timber made use of, which is calculated at nearly 3 cubic feet per running yard, its value in the forest being almost nominal. It is, of course, optional to use iron instead of wooden rails, but the road would then cost at least 4*s* per yard, without reckoning the value of the wood used for sleepers, and great difficulty would be experienced in getting the iron rails on to the ground.

By the other method (Plate V.) sleepers are also used, but at greater distances apart, viz., from 15 to 20 feet, and do not necessarily rest directly on the ground, but may be supported from beneath according to circumstances. The rails made use of for this method have a height or depth of nearly 7 inches and a thickness of 3½, which admits of small sleepers about 4″ by 1″ being fixed into them in the

same manner as the steps or *rungs* of a ladder, at intervals of about 2½ feet. They are generally secured to the rails by screws. This latter method of construction may be styled the ladder tramway, as anyone can at once realize how it is made by supposing a series of enlarged ladders, each complete and rigid in itself, laid along the ground or across brooks, ditches, &c. It is adopted chiefly in boggy or uneven soil, and where the road must be raised above the level of the ground—in short, wherever the workmen cannot walk on the ground when pushing the waggon, but must make use of the small sleepers as a footway.

The ladder construction is a little more expensive than the other, but Herr König intends introducing it generally in repairing or laying down new lengths of road, as it is most convenient for the workmen pushing the waggons, which more than repays the slight extra cost.

Plates VI. and VII. exhibit the different descriptions of supports made use of when the road runs on uneven ground or along a hill side, crosses ravines, streams, &c. These are very varied, and Herr Konig has learned how to take advantage of every local circumstance to construct a road at once simple and strong, and perfectly adapted for the purpose for which it is intended. The plates speak for themselves and are better than any written description.

Two of the larger bridges are represented in Plates VIII. and IX., the latter being a curve or *skew* running at a height of upwards of 30 feet above the bed of the stream or "*nullah*." To quote Forstmeister Fankhauser, "The "construction of these bridges is really wonderful; they "are remarkable at once for the simplicity and the solidity "of their construction."

There are, of course, numerous smaller bridges over the streams which occur frequently throughout the distance traversed by the tramway.

The trollies or waggons made use of for transporting the logs are nearly 8 feet long and about 3½ feet broad (Plate X.). The wheels which were at first made of wood, bound with iron, but which are now generally cast iron throughout, have a diameter of nearly 20 inches (50 centimètres), with a flange of a little over half an inch thick and 2 inches broad, revolving in an iron axle rather more than an inch square. These trollies weigh from 3½ to 4 cwt., and are stated not to cost more than 4*l.* each. The average load is 30 cubic feet, and two workmen are required for each to apply the break in going down hill and push back the empty trolly (Plate XI.) The former requires some prac-

tice, not only to regulate the speed, but to do so in such a manner as not to throw the trolly off the line, particularly in going round curves or where the *road* is lower on one side than on the other; under these circumstances great care is required in applying the break, and accidents have occurred from its being applied on the wrong side, resulting in the trolly, load, and workmen being precipitated into the gully beneath. No serious damage has hitherto resulted, though it appears marvellous how the workmen escaped with their lives. I think I have now described the tramway in sufficient detail to ensure its construction and working being thoroughly understood by the help of the plates.

There are no real mechanical difficulties in the arrangement; all is simplicity itself. Should the construction and working of such a road be attempted in India, our difficulty would I fear lie in getting handy and fearless workmen to construct and work the line, and energetic forest assistants and overseers to plan and lay down the way according to local circumstances and superintend its working to the best advantage.

Most of the felling and transport is here done by contract at very moderate rates, amounting to about 1½*d.* per cubic foot up to the commencement of the *slip*. I give an estimate of total cost of transport at the end of this report.

Two improvements in the tramway suggest themselves, viz., the laying down a plank or footway along the centre or on both sides where the line crosses gullies or ravines, in order to decrease the danger of falling through, and an improvement in the break arrangements which are rather rude. It would also probably be found practicable to arrange for the empty trollies being pulled up by the laden ones throughout the whole line, as already suggested, by which much time and labour would be saved.

The Wire Rope Slip.

Several attempts have been made of late years to make use of the wire-rope or cable for transporting timber from hill forests to the plains or from one side of a ravine to another. Notably in the year 1861, by one Johann Pradi, in the Tyrol, who may be said to have been the first to adopt it as a timber slip. Prade's arrangement, however, was merely adapted to the transport of small pieces of timber and faggots and was exceedingly primitive in its construction.

Its chief faults appear to have consisted in, 1st, the in-

sufficient stretching of the rope, which resulted in its being readily and frequently broken.

2nd, the arrangement of the supports and construction of the waggon or rollers, which was so faulty that the slightest unevenness, or even a strong gust of wind capsized the load.

3rd, the want of any means for regulating the speed, and returning the empty carriages.

The idea, however, having once been originated and proved practicable, required only time and careful consideration to be developed and worked out.

It is unnecessary to detail the several attempts which have been made in this direction; suffice that wire rope slips have now been introduced, and worked to a considerable extent for the transport of timber in the Tyrol, in Styria, and Switzerland, and that the most successful appears to be that of Herr König near Alpnach worked in connexion with the wooden tramway just described.

The wire rope or cable made use of by Herr König (Plate XII.), has a diameter of about 1⅛th of an English inch (3 centimètres), and is composed of six distinct rolls or bundles of six wires each. The thickness of the individual wires is 3 millimètres (0·03937 of an inch). In the middle of each roll is a hempen cord, round which the wires are twisted, and a thicker hempen cord or rope occupies the centre of the whole cable. Each separate strand, and the several bundles are twisted like a rope, and were coated with tar to prevent rust; the cable weighs 5½ lbs. per running mètre (3·3 feet), and the whole length, which is *close on* 7,000 *feet*, a little over 5 tons.

The cost per kilogramme is given by Förstmeister Fankhauser at 70 centimes, which represents about 17 pence a yard weighing 5 lbs. avoirdupois.

This cable was manufactured partly by Stein of Mulhausen, and partly by Oechslin, of Schaffhausen in Switzerland, and has proved most durable under very severe tests.

It can readily be imagined that it was no easy task to get this enormous length and weight of cable into the required position. Even had it merely been required to lay it along comparatively level ground, considerable care and labour would have been necessary, but when we consider the very uneven nature of the ground to be traversed across the rocky bed of the little Sohlier river, and up a very steep hill-side, and bear in mind that the cable had to be supported and secured throughout, and sometimes at a great height in order to ensure the requisite fall, the diffi-

culties appear almost insurmountable, and one cannot too highly admire the energy of the man who overcame them.

Herr König's procedure appears to have been as follows: Having fixed on the points of departure and arrival, the former at a spot known as the "Eggbrunnen," where the tramway ends on the brink of the steep valley of the Schlier, and the latter on the other side of the valley where the road from Alpnach terminates, he proceeded to clear and mark out his line and select any natural supports of which he could avail himself, such as strong trees to which he could fasten the cable.

When such were not found, artificial supports had to be erected as well as a stand for the workmen whose duty it would be to pass the full and empty waggons where they meet exactly in the middle of the journey (Plate XIII.). Specimens of these supports are shown in Plates XII., XIV., and XV., and it would be impossible and needless to explain each in writing.

Having selected and constructed the supports, the next step was to have the cable carried into position, which was effected after great toil and difficulty by the aid of upwards of 100 men.

No natural support or means of securing the upper end being found in a direct line at the top, the cable has been secured to a strong fir tree. At one side, as shown in plate I., *a a a*, its place being taken for some 40 or 50 feet by an iron rod, or more correctly speaking tube, supported on a wooden rail attached to three strong tripods (Plate I. *B B B*). This rod is not essential, and only used for the reasons just stated, but the arrangement appears to facilitate the transfer of the timber from the trolly, and give increased stability. The rollers to which the timber is attached press readily and smoothly from it on to the cable itself, which besides being firmly secured to the tree as shown in the drawing is also supported at *c* (Plate I.)

The face of the upper portion of the rope is about 35 per cent., and here it is kept in position by numerous supports between which it is often suspended at a height of 60 feet from the ground; further down is an open space in which is situated a second apparatus for regulating the speed, to be described hereafter, and here the gradient is much less steep. Shortly after leaving this point, it crosses the Schlier at a height of 250 feet above its rocky bed, and it is here that it makes its longest span, which is estimated by Forstmeister Fankhauser at 540 mètres or 1,782 feet,

without any intermediate support. This is naturally its weakest point, and such long spans are always to be avoided if possible.

Herr König's confidence in its security may be imagined from the fact that when he visits the upper portion of the line, he generally performs at least the first part of the journey in a basket attached to the empty carriage, and his son, who acted as my guide, informed me that he also had made several trips down and up the slip.

The cable, however, did break last year about the centre of the long span just after the visit of the *Swiss Forest Verein*, but no load was passing at the time, and the repairs are stated to have been readily carried out by the permanent employés, and within 24 hours the *line* was at work again.

To effect this, it was necessary to loosen the cable and its supports throughout the whole length, splice the ends at the broken part, and then restretch it by means of the apparatus for the purpose and secure it again to the supports.

The arrangement for stretching or straining the cable is shown on Plate XVI., and consists of a solid roller or drum about 3½ feet long and 1½ feet in diameter fixed between two strong trees.

Round this the surplus cable is rolled and secured by means of strong chains. The drum is made to revolve by the working of two strong beams which act as levers, and in this manner the cable is tightened or loosened as required. This apparatus might, I think, be greatly improved, and its working power increased by mechanical means, and it would appear possible and advisable to work it by a crank instead of the two levers. At present, all that can be said of it is that, although rude, it is effective and simple in construction.

Having thus described how the cable is laid and strained and when necessary repaired, I proceed to describe the waggon or carriage to which the load is attached (Plate XVII.). This consists of two bent iron rods about an inch square, fastened to two cast iron grooved rollers which run on the wire rope. The rods are kept at the requisite distance apart by means of a wooden pole from 10 to 15 feet in length, according to the dimensions of the logs being transported. The rollers are 11 inches in diameter, and 2·765 inches thick, with a groove of about ¾ inch deep, and of the same breadth as the cable itself, viz., about

1¼th inch. The depth of the groove ensures a firm hold, and the iron rods are bent at such an angle as to bring the lower end exactly under the cable, and thus ensure the pressure or strain being perfectly perpendicular, failing which, there would be a tendency to "*run off the line.*"

The load is secured to the carriage by means of chains passed round the logs when on the tramway trolly and fastened by swivels or hooks. The weight of the carriage with the chains varies from 155 to 175 lbs.

The load best adapted for working this cable is found to be about 1,320 English pounds, or say 26 cubic feet, but it can and has carried loads of 2,200 lbs. or 44 cubic feet.

Loads under 400 kilogrammes (882 lbs.) are not found sufficient for drawing up the empty carriage with the wire cord, the use of which I am about to explain.

One of the great difficulties hitherto experienced in working "wire tramways," as they have generally been called, has lain in the regulating of the speed and securing a perfect command over the carriage and its load throughout its course. Herr König appears to have overcome this in a most simple manner, retaining the single rope or cable instead of having recourse to two, one for the ascending and the other for the descending carriage, a method which has been practised elsewhere, but is objectionable if only for the reason that it doubles the cost and labour o construction.

Herr König makes use of a wire cord weighing about one-third of a pound, and costing about 5*d.* per running yard. One end of this is fastened to the upper end of the laden carriage, and the other to the empty carriage, which has to be returned empty.

At the departure station this cord passes round two wooden drums, to the uppermost of which a simple brake is applied, as shown at A, Plate XVIII., by referring to which the whole arrangement will be readily understood, and it is scarcely necessary to state that the weight of the descending laden carriage suffices to draw up the "empty," and that the speed of the former is regulated by the break at the top or departure station, where two men are generally posted, only one of whom however is generally "on duty" at one time. After a little practice these men get to know to a nicety where the laden carriage is, and regulate the speed accordingly, bringing it to a standstill half way, where the empty carriage is met and passed by the descending one.

Owing to the great length of the Alpnach cable, it has

been found necessary to have two lengths of wire cord and two brake stations, one at the upper end and one half way down. Were the cord in one piece, its weight, and that of the empty carriage, would have required a heavier and excessive load on the descending waggon to pull them up. Thus whilst the main cable or wire rope is in one piece throughout, and the laden waggon has never to be removed from it, the cord and brake arrangement is in two parts. That shown in the plate is the system adopted at the second or lower station, that of the upper being of older date and less effective.

As stated above, the laden and empty carriages meet midway between each station, and Plate XIII. shows the meeting station in the upper portion of the line where it has been found necessary to erect a platform 65 feet high, on which two men are stationed, who lift off the light empty carriage and attach it again above the laden one, which has been brought to a standstill by the brakesmen above on the sounding of a horn. On reaching the second or lower station the cord is of course disconnected and attached to an empty carriage, and the load passed on down the cable with the second length of cord attached. It can readily be understood that the weight of the cord does not permit of its remaining suspended in mid air without supports, and that some portion of it is therefore as a rule on or close to the ground, and in order to decrease the friction to a minimum it has been found advisable to have wooden rollers fixed at short intervals over which the cord can run, Plate XVIII., Fig. 2. The number of employés found necessary for the working of the wire rope slip is 11, who together received 25*s.* per diem. They are thus distributed, viz., at the upper station three men to load the carriages and attend to the breaks, two men at the lower break station, and the same number at foot of the slip, with two at each of the half way stations where the carriages meet.

An overseer is employed to supervise the whole work both on the tramway and slip and the felling. All repairs can be executed by the permanent employés, even to that of splicing the great cable wherever it may be broken.

Herr König states that he can transport 20 loads daily down the slip, equal to about 500 cubic feet of timber, and estimates the expense at 1*d.* per cubic foot. Forstmeister Fankhauser states that during the winter, with a moderate quantity of snow, the same results might be arrived at by ordinary slipping, but proceeds to point out with truth

that the proper quantity of snow cannot be relied upon when it is necessary to slip from 40,000 to 50,000 cubic feet of timber during the year; besides the timber arrives below in much finer condition. The wire rope slip is not worked at all during the winter months. I come now to an estimate of cost of transport as given by Forstmeister Fankhauser.

It must be borne in mind that the trees when felled are barked, and the firewood converted into charcoal, both of which are sold on the spot at a considerable profit, really more than sufficient to pay all the current expenses.

I shall, however, confine myself to the timber, the felling and transport of which along the tramway to head of slip costs, as already stated, on contract - 1½*d.* per cubic foot.

The transport on the slip costs -	1*d.*	„
„ from the slip to the lake - -	1*d.*	„
„ to Lucerne by boat	½*d.*	„
Wear and tear of tramway slip -	1*d.*	„
Equals a total cost of - - -	5*d.*	„

delivered in Lucerne, where it is readily sold for 1*s.* per cubic foot, leaving a clear profit of 7*d.* per cubic foot after deducting all expenses, and without taking into account the value of the bark and charcoal.

In concluding this short report I may state that I am aware that somewhat similar slips, or what are called wire tramways, are in use in some parts of Wales for the transport of ore from mines, &c. In 1870-71 also I find that a project for a wire tramway from the Mayo salt mines to Miani, in the Punjab, at an estimated cost of 10,000*l.*, received the approval of the supreme and home Governments, and has doubtless since been carried out, but I am not aware with what success.

Whilst writing this report also, I observe that the Wire Tramway Company Limited, from which a portion of the materials for the latter undertaking were procured, is in process of liquidation, so that probably the system as carried out in England has not proved successful.

I am not, however, aware of its ever having been tried either in England or India as a means of transporting timber from hill forests, for which purpose it would appear specially adapted. I need at the same time scarcely point out that the great merit of Herr König's tramway and slip lies in their extreme simplicity and the cheapness with

which they have been executed, and it is only by following in his footsteps in these respects that we can ever hope to introduce them successfully in our Indian forests.

I am inclined to think that the tramway* could be laid down and worked to advantage in many of our forest districts; the wire rope slip would be more difficult, but at the same time more useful in many places. I trust this report may be found of some use to forest officers desirous of introducing either.

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* We have wooden tramways very like the one described at work on all the Tonse sleeper works in the Himalaya.—G. F. PEARSON.

En to 102 Forests.

PLATES

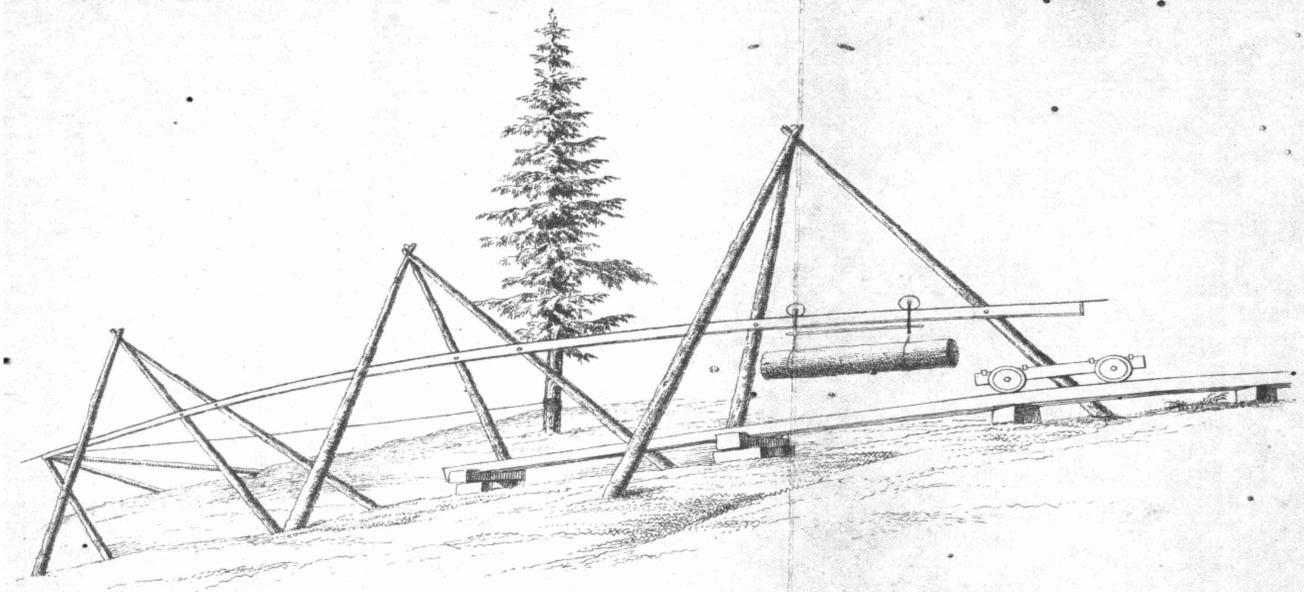
to accompany

Capt. Walkers Report on the

WIRE ROPE TRAMWAY.

PLATE I.

Lower end of Tramway and commencement of Wire Rope slip



Lith. Lips, Bern.

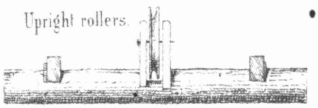
Tramway.

Unthern Branch.

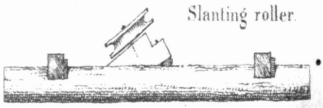
Lith. Lips, Bern.

Tramway.

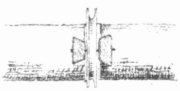
Small rollers for supporting narrow wire rope connecting trollies.



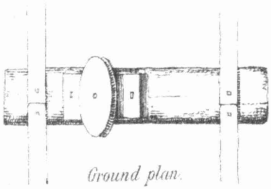
Section.



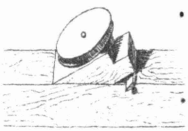
Section.



Ground plan.



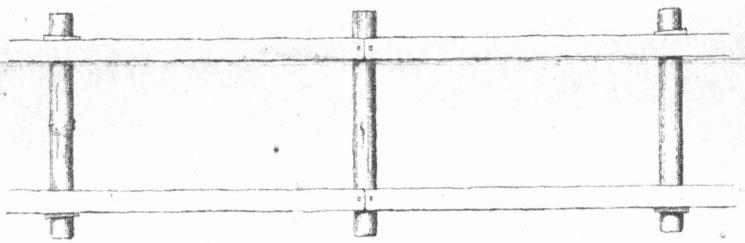
Ground plan.



Side view.

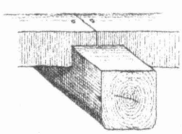
Tramway.

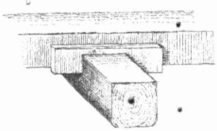
Wooden rails and sleepers 1st Method.



Ground plan.

Sleeper.
Cross view

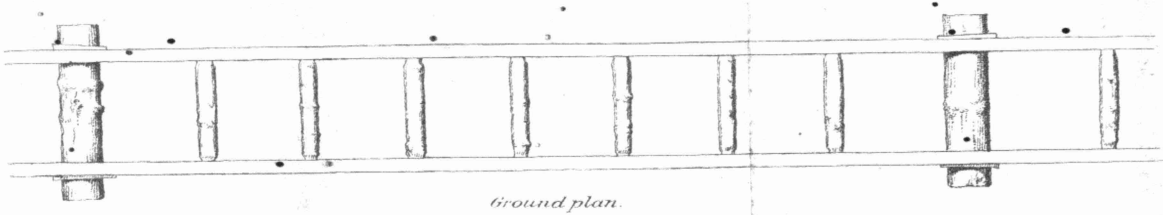




Method of securing the rail to sleepers.

Tramway.

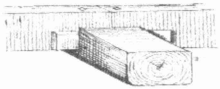
Wooden rails and sleepers, 2nd method or ladder arrangement.



Ground plan.

Side view.

Cross view of tenail sleeper or step

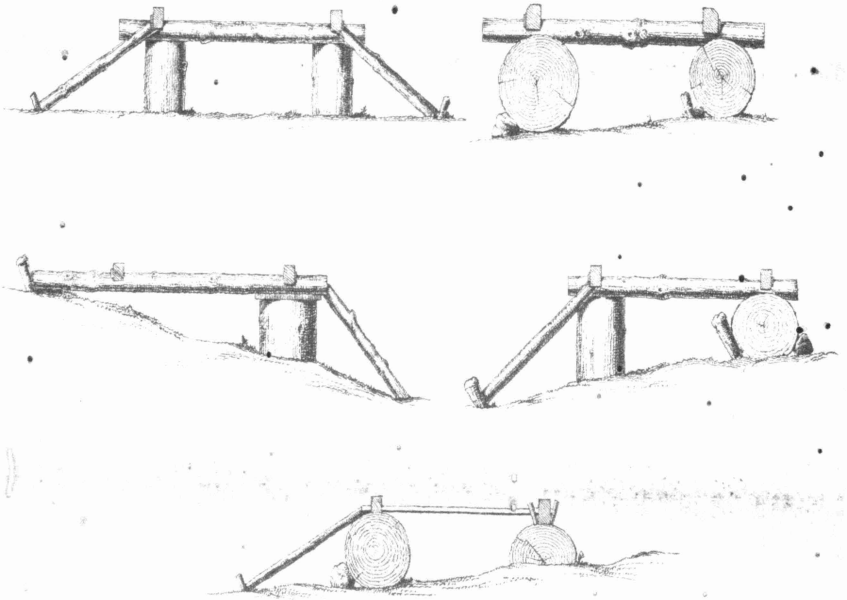


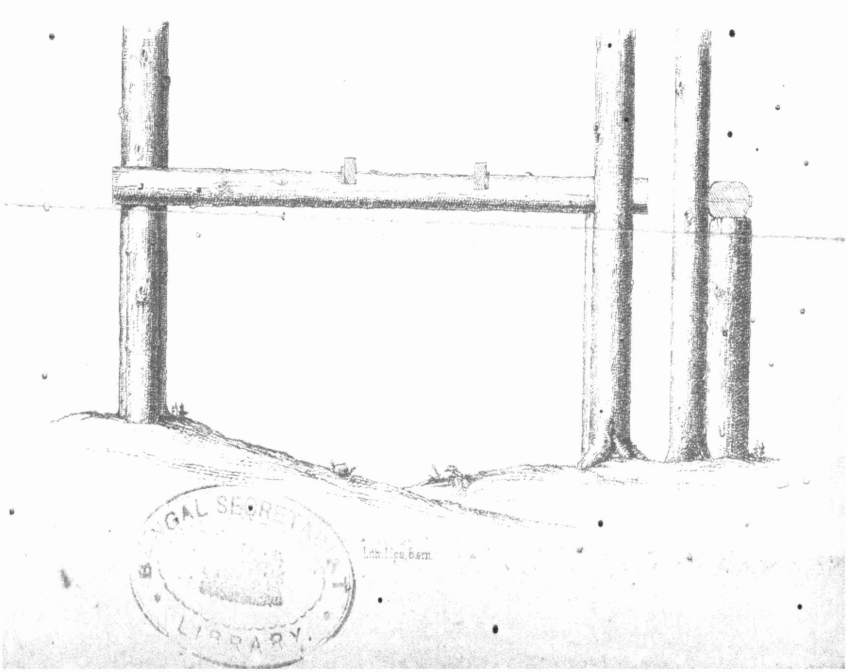
Method of Fastening.

Lith. Lips, Bern.

Tramway.

Sleepers with supports.

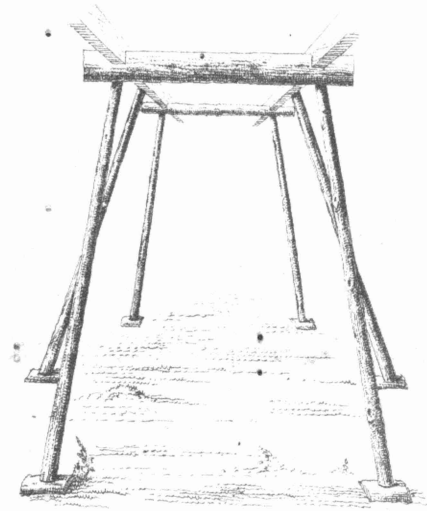


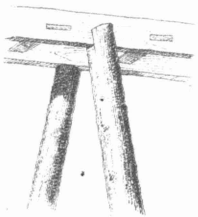


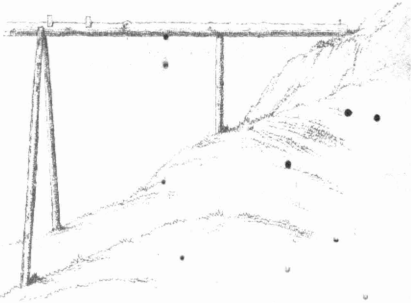
LEGAL SECRETARY'S LIBRARY.

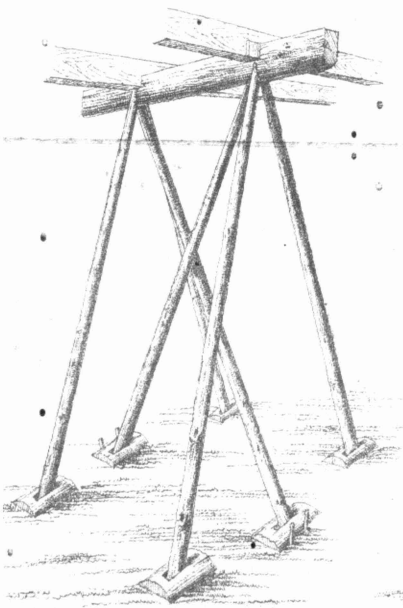
Tramway.

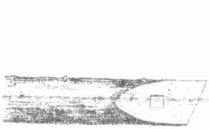
Supports.

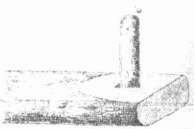


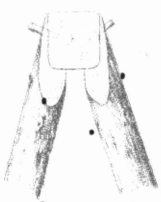


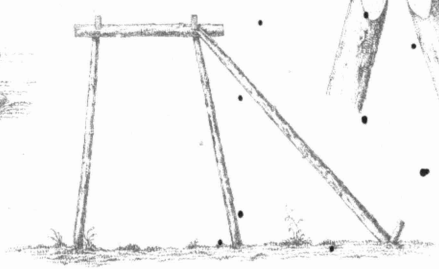








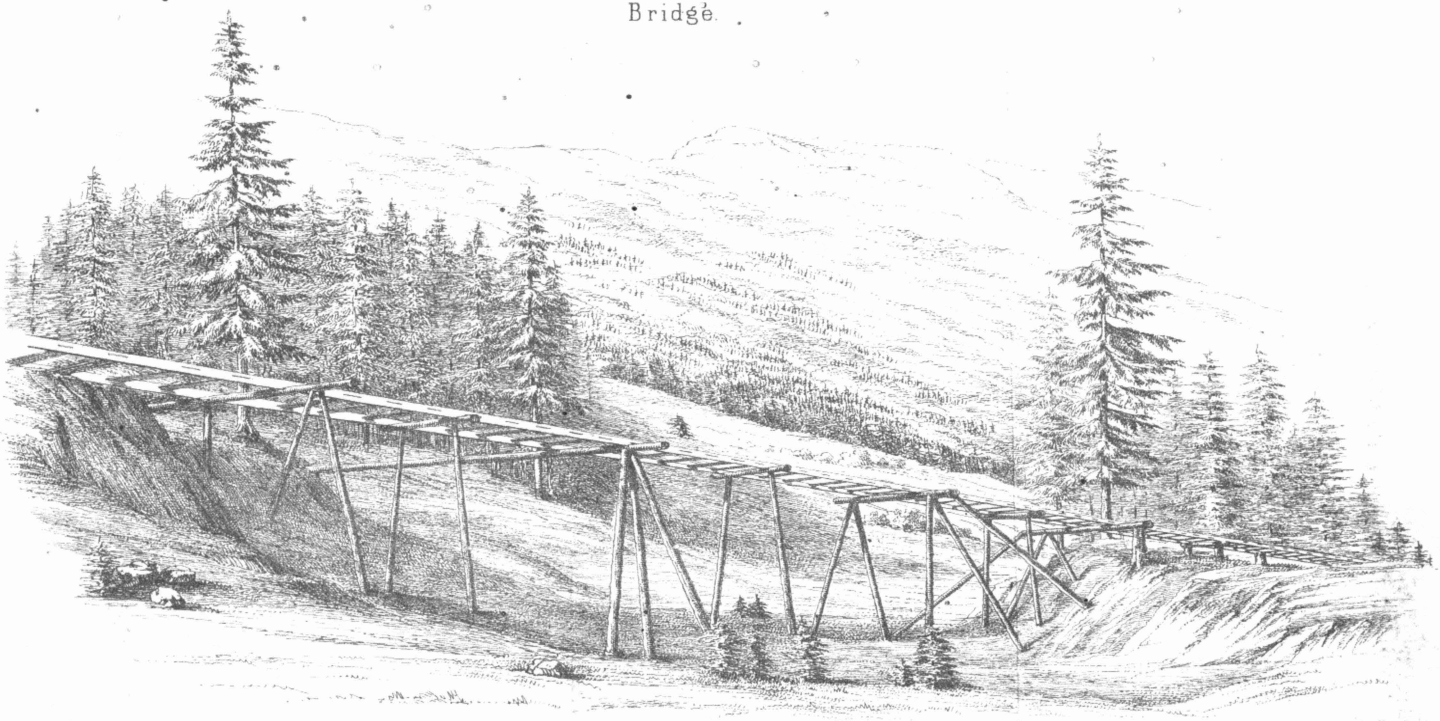




Lith Lips Bern.

Tramway.

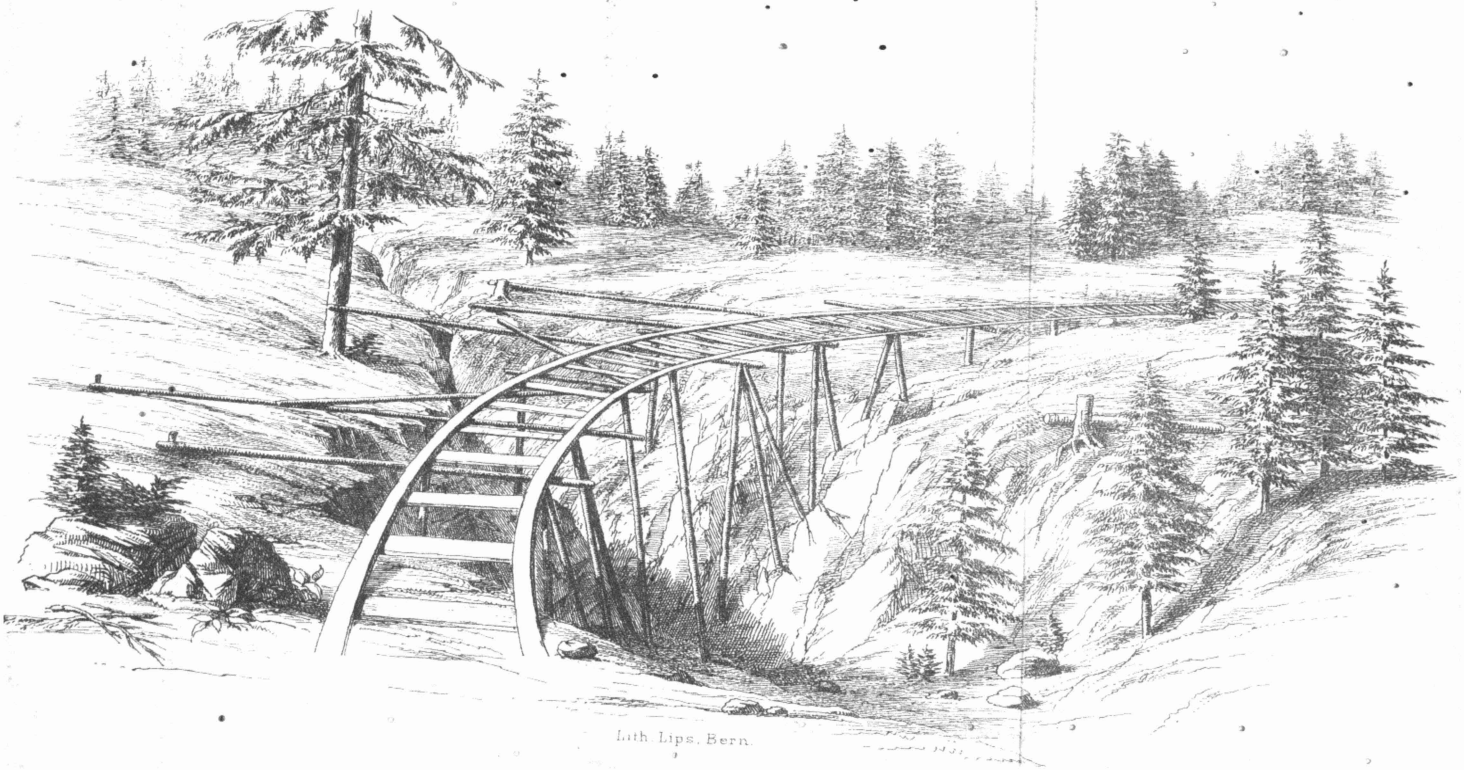
Bridge.



Lith. Lips, Bern

Tramway.

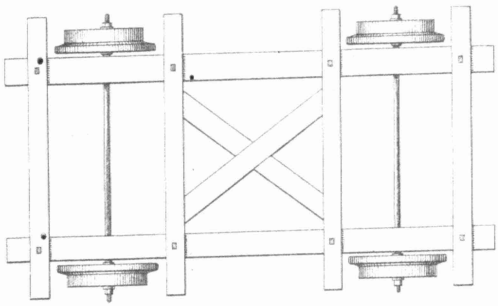
Curved or Skew Bridge.

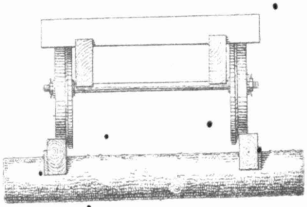


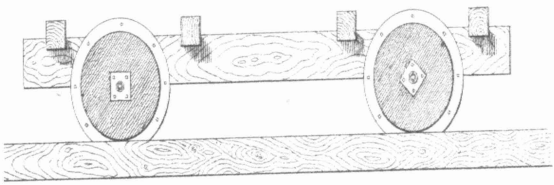
Lith. Lips, Bern.

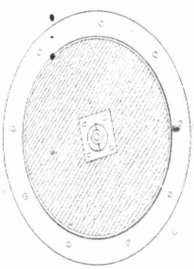
Tramway.

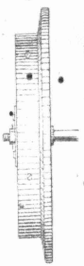
Trolly with wooden wheels.



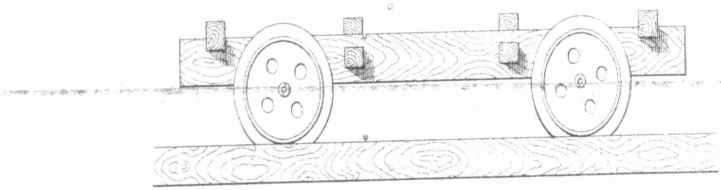


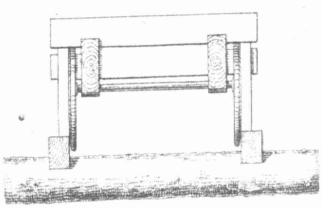


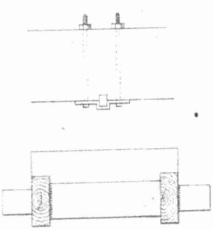


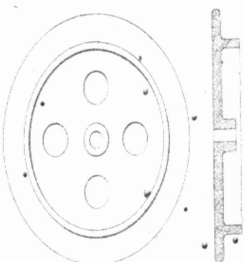


Trolly with iron wheels.





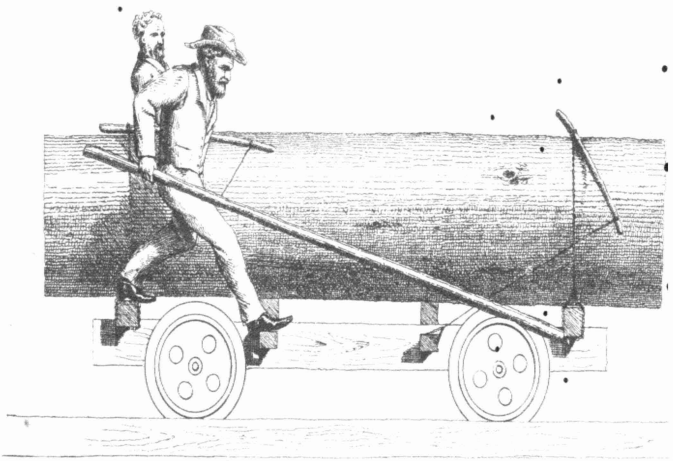




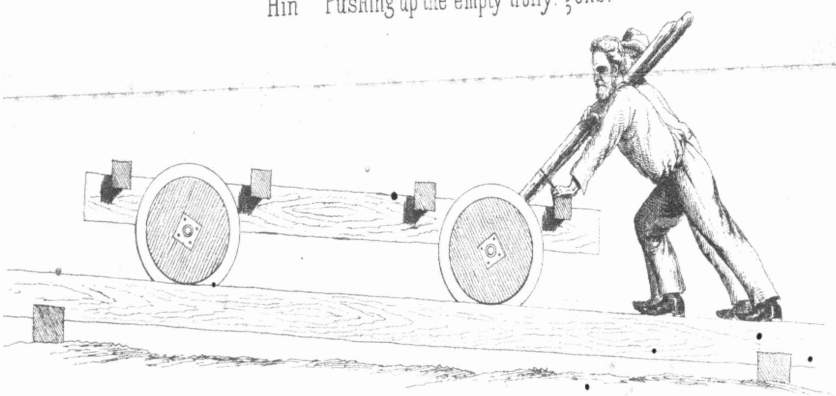
Lith. Lips. Bern.

Tramway.

Method of applying drag or break.



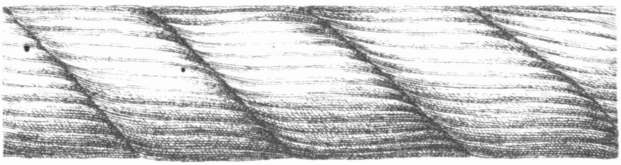
Hin Pushing up the empty trolly. ʒens.

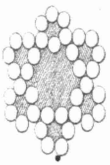


Lith. Lips, Bern.

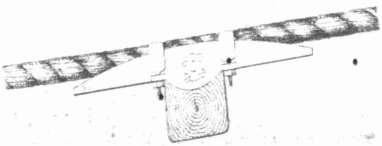
Wire Rope slip.

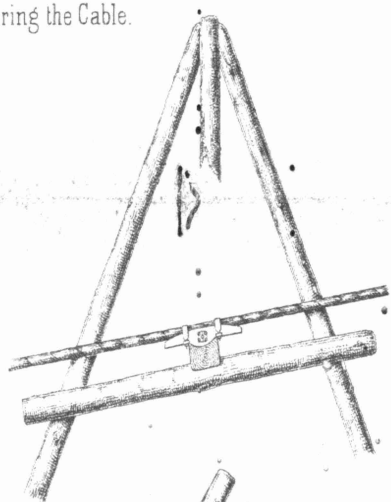
Wire Rope or Cable.

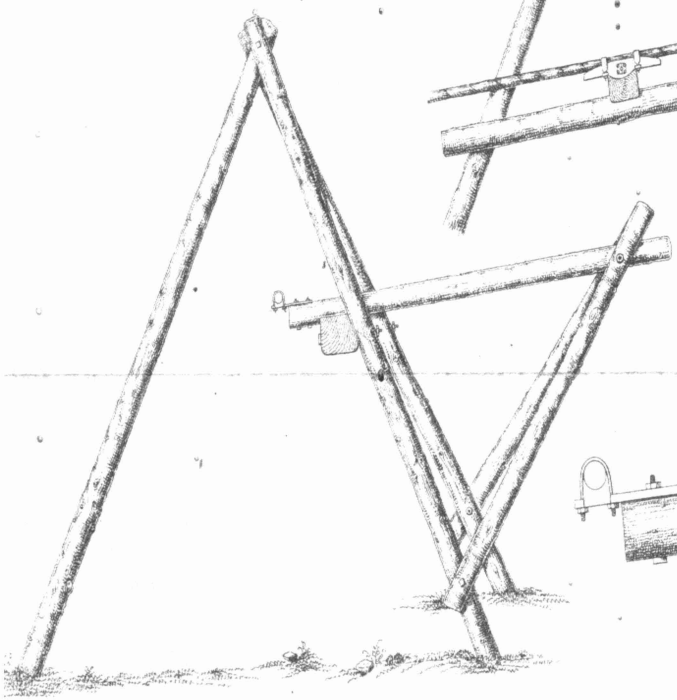


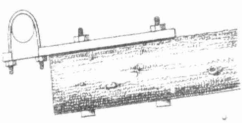


Method of securing the Cable.





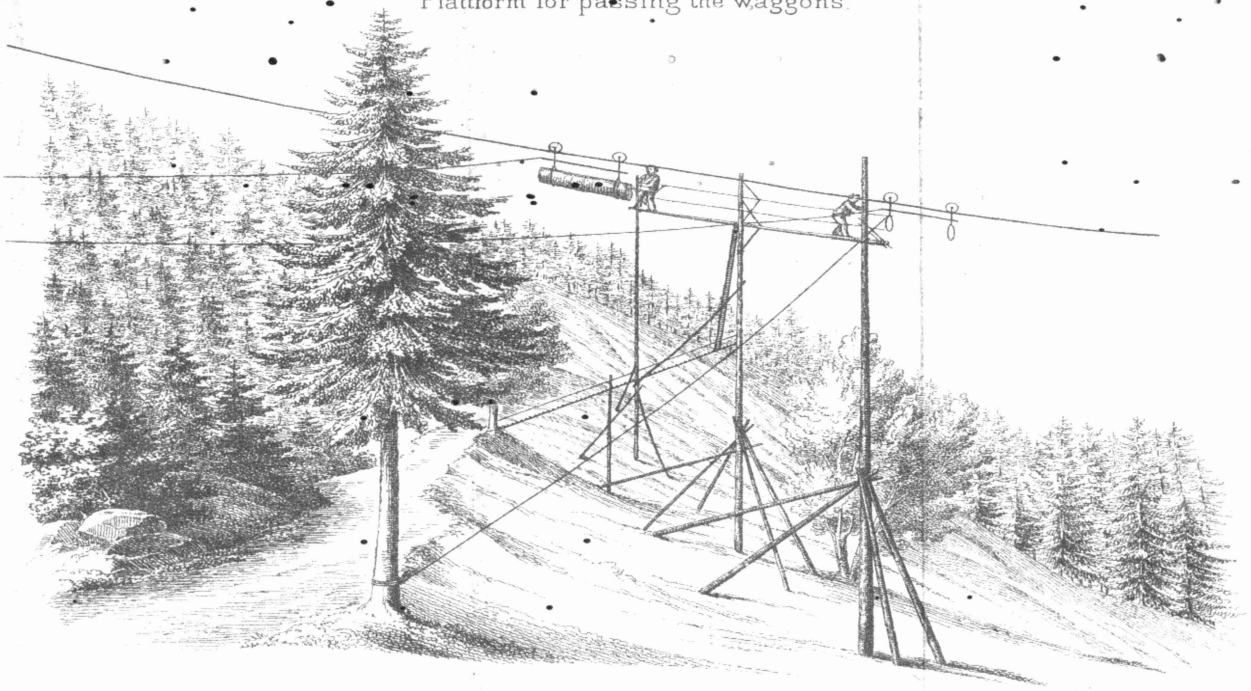




Lith. Lips Bern.

Wire Rope slip.

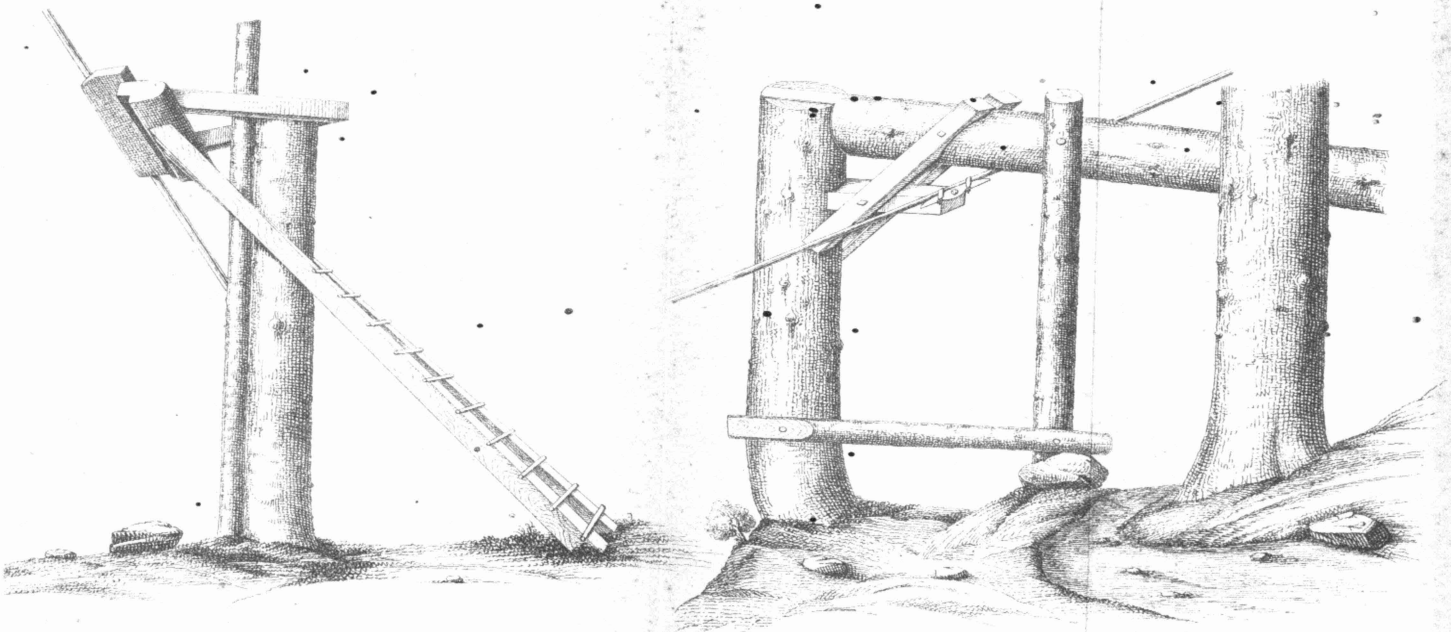
Plattform for passing the waggons.



Lith. Lips, Bern

Wire Rope slip.

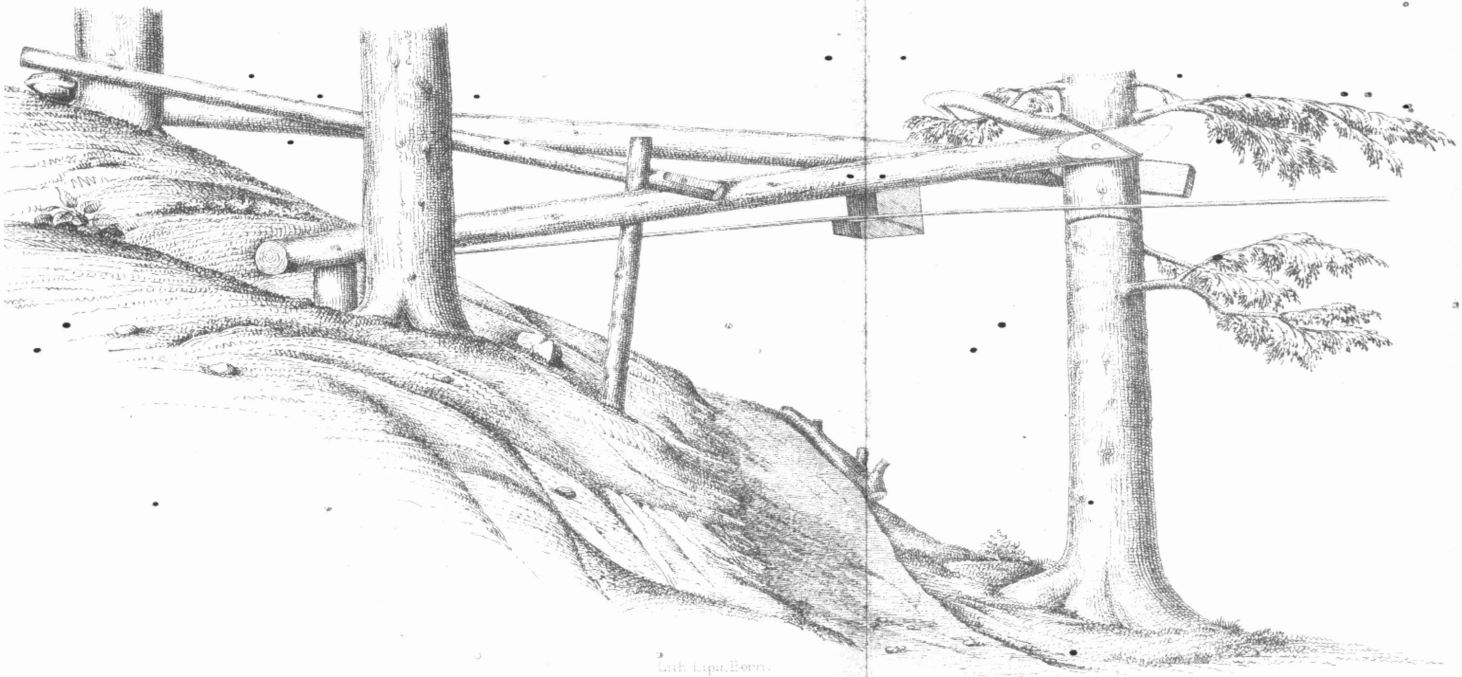
Supports.



Lith. Lips, Bern

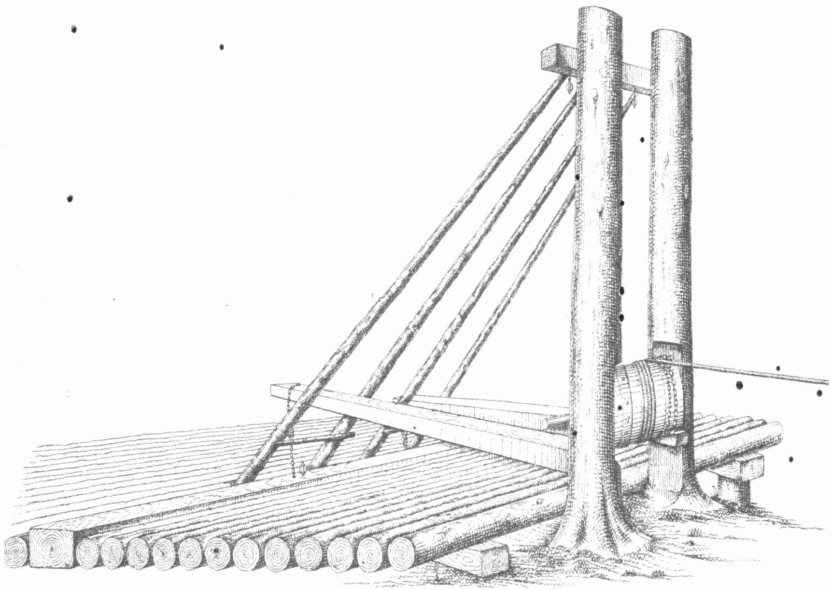
Wire Rope slip.

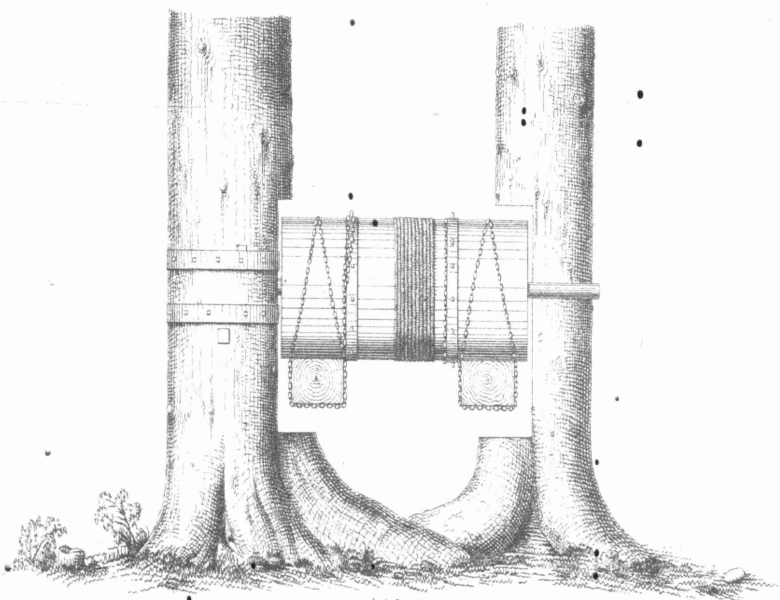
Supports.



Lith. Lips. Bern.

Wire Rope slip.

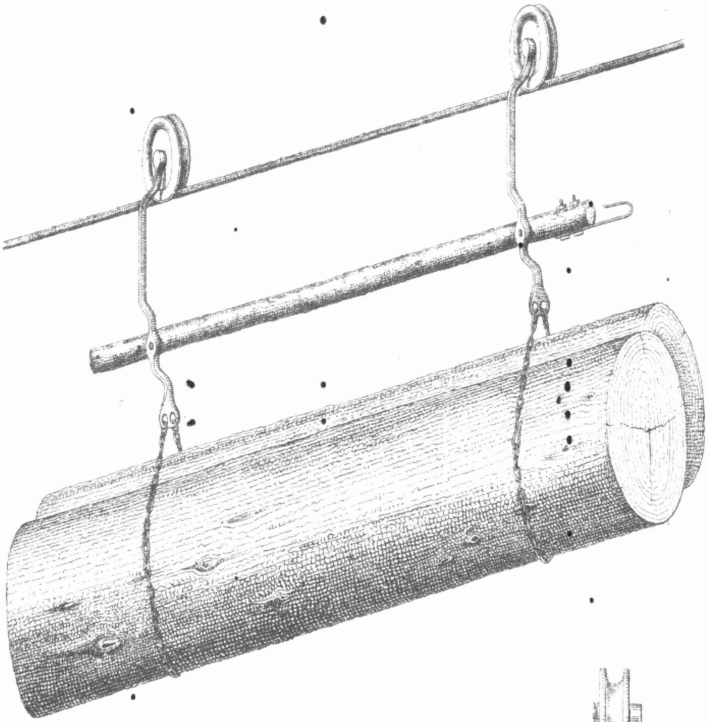


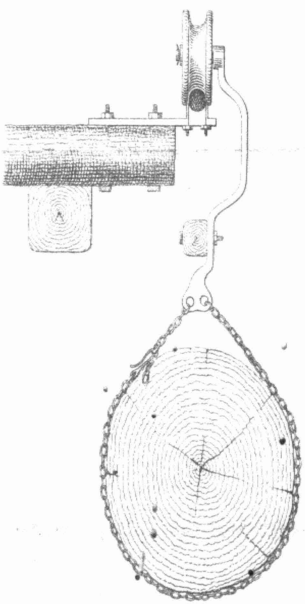


Lith. Lips Bern.

Wire Rope slip.

Waggon-Carriage with load attached.

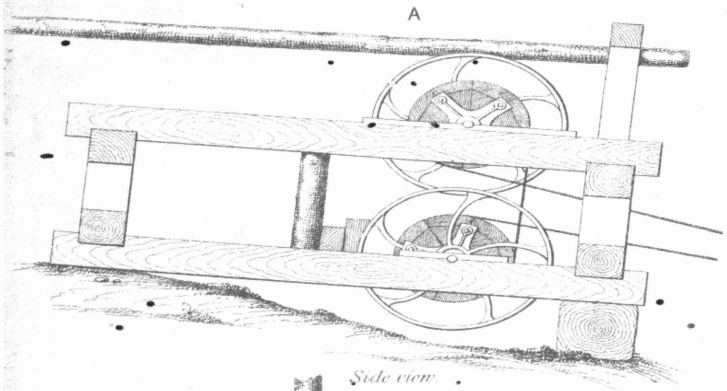




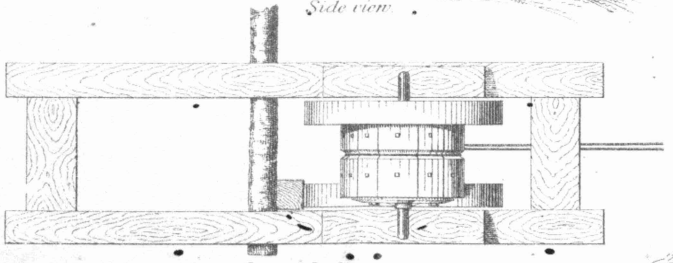
Lith. Lips Bern.

Wire Rope slip.

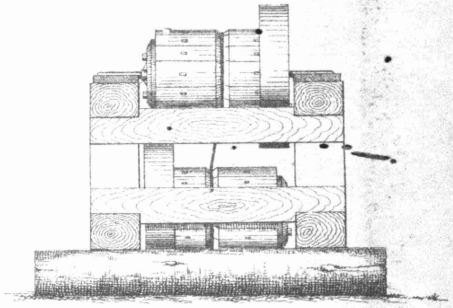
Arrangement of the break.
Apparatus double cord.



Side view.

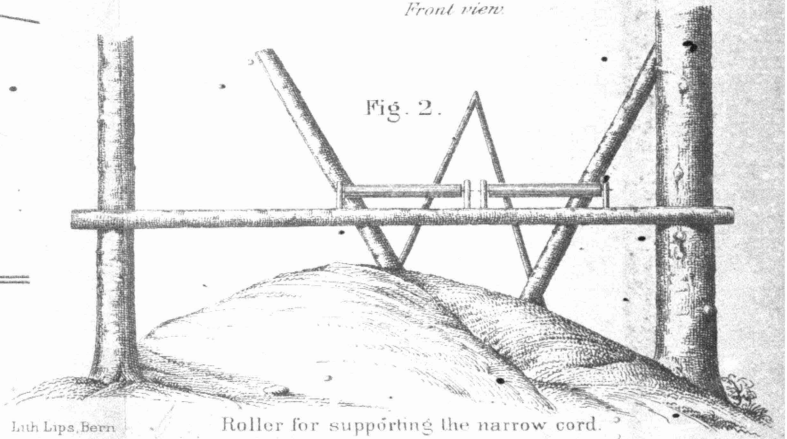


Ground plan.



Front view.

Fig. 2.



Roller for supporting the narrow cord.

Lith Lips, Bern

III.

On the Working of the Forest of Waidhofen, Lower Austria.

Mr. F. d'A Vincent has communicated to me a copy of a report which the Austrian Company for the working of Forests (Österreichische Action gesellschaft für Forst-industrie) has published on the occasion of the late Vienna exhibition concerning the management of their forest property near Waidhofen in lower Austria, and as a visit to these forests cannot fail to be highly instructive to Indian Forest Officers, I will in the following remarks give a brief abstract of that publication. Mr. Vincent has visited the forests and has furnished me with some additional notes. In 1869 the property was purchased by the company; the forests originally belonged to the state, part was alienated in 1824, part in 1864. This latter portion was bought by a large timber trading firm of Strassburg, who are said to have worked it in a most reckless manner without any regard to its maintenance.

2. The area is 49,000 Austrian joch, equal to 65,800 acres, and in addition contracts have been concluded with several of the surrounding proprietors for working a large extent besides. The forests are drained by two rivers, the Ips, which joins the Danube near the town of that name and the Erlaf which falls into the Danube near Pöchlarn. These two rivers form the principal lines of export for the timber of these forests, and for its conversion two large steam saw mills have been established at Amstetten on the Linz-Vienna railway for the timber brought down by the Ips and at Pochlarn for the wood floated down the Erlaf, where also timber brought down by the Danube is cut up. The timber converted and sold annually by the company is stated to amount to 1,600,000 cubic feet, more than $\frac{3}{5}$ of the average annual yield of the Government forests in British Burma during the last three years (50,000 tons). The timber transactions of the company therefore are of considerable magnitude, but their principal interest for Indian foresters consists in the local difficulties which had to be overcome in order to make this large quantity available the market, and in the arrangements made to ensure a permanent yield from their forests, many of which

when taken over were in an impoverished condition. Waidhofen, the head quarters of the Director of these forests,* is situated on the Ips and on a branch railway which leaves the main line at Amstetten. Its elevation is 1,143 ft., but the mountains on the sides of which the forests are situated rise to 5,000 ft., and several peaks attain nearly 6,000 ft., thus exceeding considerably the upper limits of arborescent vegetation in that portion of the Austrian Alps.

3. The principal rocks are limestone and dolomit, and the forest is mainly composed of the following trees: *Spruce*, which attains 4,500 ft. and is the prevailing tree; *Larch* which ascends to 3,200 ft., grows more rapidly than the *spruce*, suffers less from frost while young, resists storms better by means of its deep going roots, and at the same time yields timber more valuable than any of the others; *Beech* often mixed with the *silver fir*, up to 3,000 feet, not much valued here, though it spreads itself more readily by self sown seed than any of the other trees, and lastly *Scotch fir*, principally on warm dry southern slopes but not ascending beyond 2,200 ft., and the mountain fir (*Leg föhre, Pinus Pumilio*) which forms the upper limit of the forest, ascending to 5,500 ft., covering large extents of ground where no other tree will grow, with its half creeping interlaced stems, invaluable for the protection of steep stony slopes and of places exposed to avalanches.

4. In these mountains all felling is done in summer and the land transport of the timber to the rivers is either effected on slides and tramways, or over the snow in winter. From the account before me I gather that the timber slides and tramways here are similar to those of Friaul and Idria, but on a much larger scale and evidently planned, constructed, and worked in a most systematic manner. In the Black Forest, the timber slides are generally laid on the forest roads, which are constructed for that very purpose, and thus form a permanent foundation upon which it is sufficient to place the logs over and between which the timber is to be slid down. In the Alps, however, roads are the exception, and most elaborate constructions of timber are built to cross ravines and valleys, or to pass along rocky precipices. The floating also on the rivers which drain these forests will afford much instructive information. On the Erlaf firewood and timber is drifted down in single pieces, and to facilitate this operation the

* Wilhelm Freiherr v. Berg, a well known forest officer from Saxony.

whole river and some of its tributaries, aggregating about 40 miles, were cleared by rectifying their course, blasting obstructions, protecting the banks, fixing the bed of the river by cross sleepers and similar works; a path along the river was built and the old works for storing water (Wasserclausen) were repaired and new ones constructed. April and May are the principal months for floating on this river, and the timber is caught by an ingeniously constructed timber rake (Holzrechen) at Pöchlarn. The loss in floating on this river formerly amounted to 18 to 20 per cent. of the timber thrown into the river, and since the completion of these works the loss has been reduced to 12 per cent.

The floating on the Ips is effected in long narrow flexible rafts in a manner similar to the system in force on some of the Schwarzwald rivers, particularly the Kinzig and tributaries, but the Ips is a larger river and the water supply more steady, so that floating is carried on throughout the summer and not at certain seasons only as in the Schwarzwald. The arrangements here were originally made by men brought on purpose from the Black Forest, and Indian forest officers will thus have an opportunity of studying this interesting and instructive system at any time during the summer months

5. Before the company commenced their operations natural reproduction was principally relied upon for the regeneration of these forests, but the results have not been satisfactory, and consequently there are extensive areas blank or imperfectly stocked. To a certain extent this is also due to the reckless working of part of the forest by their immediate predecessors. The present administration has come to the conclusion that, under these circumstances, sowing and planting must be resorted to on a large scale, and the report shows that a good beginning has been made in this respect. Plans of operations have been established, framed apparently in accordance with the rules and principles which are in that respect in force in Saxony. These forests, therefore, furnish an interesting example of a large forest property managed by a mercantile company in accordance with strict conservancy principles.

8th November 1873. D. BRANDIS.

LONDON:
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty
For Her Majesty's Stationery Office
[.—1000.—10/74.]